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EDITORIAL NOTES

Research in the Industry

No Research Meeting of the Institution of Gas Engineers has been attended by greater success than that held in London last week. The reports presented will be of immediate benefit to the Gas Industry, and the discussions to which they gave rise, which are reported *verbatim* in this Special Number of the "JOURNAL," are of the utmost value. The meeting occupied two full days, and not a minute was lost. Sessions began and ended according to schedule, the reports were presented with a minimum of fuss and therefore with a maximum of efficiency, the speakers knew exactly what they were going to talk about, and hence interest never flagged throughout an arduous two days. Such smooth running can only be the outcome of careful planning, and it is, of course, the best tribute possible to the organizing capacity of the Secretary of the Institution, Mr. J. R. W. Alexander.

Last year what was termed a "private report" was submitted at the autumn research meeting, and in the "JOURNAL" for Nov. 11, 1931, we expressed the hope that the plan would be established as part of the annual programme, for such accounts of work undertaken by individual gas undertakings constitute a natural corollary to the more general investigations of the Joint Research Committee of the Institution and Leeds University. At the meeting under review there were three such private reports which greatly enhanced the worth of the meeting. This co-operation between the Industry as a national organization, individual gas undertakings, manufacturers of plant and appliances, and investigators in other spheres whose work has a direct bearing on the problems which the Industry has to face and solve, is being fostered; and it was one of the happiest features of the meeting. Co-operation between gas undertakings, sewage authorities, and bacteriological chemists has furthered the work of the Liquor Effluents and Ammonia Sub-Committee to an extent otherwise quite impossible of achievement. We cite this as but one example.

The discussions throughout were of an extraordinarily high technical standard—of a quality, in fact, which gives a lead to several other industries in Great Britain. We have one criticism, however—that research on manufacture overshadowed in quantity research on utilization. It is difficult, in 1932, to appreciate why this should obtain.

New Knowledge

THREE reports were submitted by the Joint Research Committee of the Institution and Leeds University. One concerns the back-run process for the manufacture of carburetted water gas, and Dr. Dent, the Research Chemist, has certainly produced a first-class account of a searching investigation into the process of water gas manufacture. As a result of the report and discussion we are left with definite knowledge of the merits and demerits of the down-run and the back-run processes; we are given a guide as to which process to adopt. For gas of 400 B.Th.U. calorific value, the back-run shows to advantage; for gas of 500 B.Th.U. the down-run has more to recommend it. Another report deals with the installation of intermittent vertical chamber ovens at Croydon; and there was ample testimony at the meeting that the report will be of direct utility to the actual designers and constructors of plant, while it was also made clear that, from the point of view of the practising gas engineer and chemist who is keen on getting the very best out of the plant, the report again has its sphere of usefulness. Certainly intermittent vertical chambers are now firmly established as a highly efficient system of carbonization. The third report is of an investigation into the operation of the Sigma recorder. The finding is that the instrument is one which may be very useful in small or medium size undertakings as an aid to securing greater uniformity of calorific value, but may not prove sufficiently accurate for its readings to serve as the basis of penal action. It may, in general, be expected to indicate the gross calorific value of town gas with an error of not more than ± 2%, and more nearly where daily checking is practicable, as it is for works purposes.

"Private Reports"

THE "private reports" are of the greatest credit to the authors and to the Industry. We will mention them in their order of presentation. First there was the paper by Mr. F. C. Smith, of the Gas Light and Coke Company, on the planning of gas installations to conform with the British Standard Specification for Street Lighting. The paper was originally presented at the meeting of the Association of Public Lighting Engineers in September last, and a lengthy abstract was published in the "JOURNAL" for Sept. 21. At the time we said that the paper shows that the Gas Industry is alive to the fact that gas has nothing to be ashamed of as a modern illuminant, that it demonstrates the value of an organization such as that at Watson House, where a competent technical staff enjoy adequate facilities for investigation, and that it is designed to be a guide to lighting engineers throughout the country.

Then we come to the report by Prof. Haldane. In common with Mr. E. V. Evans, who at the meeting bore in mind the schoolboy who started his Greek paper by saying that Homer was to be congratulated on his Iliad, we do not presume to congratulate Prof. Haldane; but we know that the Industry is grateful to him. His analysis of the memorable Holborn explosion of 1928 is fascinating, and of great importance to our Industry. It indicates the seriousness of anaerobic fermentation in the soil; how, under certain barometric conditions, vast volumes of gases may find their way into underground chambers, and may have a composition which, mixed with air, renders them explosive. In this connection the remarks of Mr. Stephen Lacey and Mr. Hollings in the discussion will be studied with the liveliest interest, for they bring new scientific facts to bear on the problem of "gas explosions," and also on the ascertainment of coal gas leakage.

An Admirable Gesture

THE third of the private reports is by Dr. Hartley, on the conversion of the potential energy of coal gas into radiant energy. We have previously had occasion to refer to the excellent research work initiated by Radiation Limited, under the able supervision of Mr. H. James Yates; and there is no doubt that the valuable results of their recent research described by Dr. Hartley constitute another step forward in the progress of the Gas Industry. We regard it as an admirable gesture on the part of Radiation to permit the publication, for the benefit of competitors as well as those responsible for the manufacture and sales of gas; and the thanks of the Industry are due to the firm. The discussion on the report was one of the best to which we have listened at any meeting of the Institution of Gas Engineers. It was full of new ideas and thoroughly inspiring; and it is obvious that gaseous heating is in process of intense development. We heard, for instance, of the probability of changes which will make a 7-radiant fire as effective a radiator as the 9-radiant fire of to-day; and we were most interested in the possibilities of incorporating translucent silica in the construction of gas fires.

The final report at the meeting was that of the Refractory Materials Joint Sub-Committee. The work of the Committee on such problems as hot-patching cements and their satisfactory application, and the permeability of retort materials, is of great practical value. That this is appreciated is evident from the remarks of the Chairman of the Committee, Dr. Colman, in introducing the Report. It is common knowledge that funds have not been adequate; but last July a special appeal for increased support was issued to manufacturers and users, and as a result increased and additional subscriptions have been promised, ensuring a grant from the Department of Scientific and Industrial Research. To this successful result the Gas Industry has been a very large contributor, the total promises by the Institution from its Research Fund and from individual gas undertakings having been increased from about £530 to £2240. The income for the year is nearly double that hitherto available, and it now becomes possible both to extend the present investigations for the Gas Industry and to put in hand additional researches which have been held back owing to lack of funds.

In the foregoing we have referred generally to a few of the outstanding features of a highly successful research meeting. As in previous years we publish on later pages a review giving a composite picture of the entire proceedings.

Time, Gentlemen, Please!

MARKED success attended the use of an original form of Speakers' Time Indicator, used for the first time at the Research Meeting. Not one of the numerous speakers at the meeting exceeded the time allocated to him—generally ten minutes—and the many technical reports were presented and discussed in strict accordance with the times allocated in the two-day programme.

The principles of the indicator were evolved some time ago by Mr. Alexander. It consists of a small, portable, and unobtrusive box, containing an ordinary pocket lamp battery and green, yellow, and red bulbs. The green light indicates that the speaker has five more minutes at his disposal, the yellow light that only two more minutes are available, and the red light that the speech must be concluded.

The indicator can be operated at will by the Chairman, or a clockwork timing device can be instantly set for a speech of such length as the Chairman may pre-determine, and the lights are automatically brought into action at the above-mentioned intervals. Embarrassment of the speaker is minimized in that the signals can be seen only by him. Considerable interest has been taken in the indicator throughout the country, and requests have been received for its loan for use at meetings of different kinds.

Tar Also

"THE Association's proposals for co-operative research on road tar having received the sympathetic consideration of the Committee of the Privy Council for Scientific and Industrial Research, a Special Road Tar Research Committee has been appointed to supervise a general programme of research. This Committee consists of five representatives each of the Association and the Department of Scientific and Industrial Research. The work is being carried out at the Chemical Research Laboratory, Teddington, under the direction of Prof. G. T. Morgan, and the cost is being divided equally between the Department and the Association. The benefits of research are obvious, and a progress report has recently been received which indicates that we may look forward through this work to the Association rendering a further service to the road industry of Great Britain." These sentences are quoted from the address of Sir David Milne-Watson (the President) at the fifth annual meeting of the British Road Tar Association, and they point to another direction in which practical benefits are derivable by the Gas Industry through research. A very large amount of experimental, demonstration, and investigatory work has been, of course, already carried out, and the Association forms an invaluable clearing house for information among all those engaged in the road tar industry. The meeting therefore came appropriately side by side with that of the Institution of Gas Engineers, which was held to discuss research.

The record of the British Road Tar Association—youthful in years, but ripe in experience—is such as to merit 100% support on the part of the companies and undertakings in the gas, coke oven, and tar distilling industries. This Sir David Milne-Watson made quite clear by his record of work done and to be done. In fact, that does not go far enough—for the work the Association is engaged upon is a national work. "Ratepayers in their own interest cannot afford," writes Lord Hereford; as President of the National Federation of Property Owners and Ratepayers, "to see the roads neglected. Nor is bare maintenance alone sufficient. Traffic is increasing year by year. Year by year our roads must grow better, if we are to maintain national efficiency." Well, it is the claim of the Association that, with scientific laying and the proper choice of materials, safe roads can be laid with tar. And this claim in favour of a 100% British product is based upon experience. Speaking at the Institution research luncheon on the day previous to the Association's meeting, Mr. J. H. Canning remarked that research in the Gas Industry had always resulted in progress and prosperity in the long run. The work of the British Road Tar Association in no way belies this statement.

Arising Out of Business

IT was a thought-inspiring address that Mr. E. J. Fox, as Chairman, delivered at last week's autumn general meeting of the Society of British Gas Industries. Mr. Fox is a man of many and large activities, and some of the convictions which are the result of his wide experience he imparted to the members of the Society. They were worth-while expressions of opinion upon subjects which arise in the conduct of every-day business, and they were presented in arresting form. His hearers could give whole-time attention to his points; there was no need to devote half of it to seeking them. As the outcome of his own experience, Mr. Fox knows, not only what a business man wants, but how he wants it.

These are days of specialization, and generalization tends to become more difficult. We should certainly hesitate, as Mr. Fox himself does, to apply it to some of the subjects introduced by him. Production on a large scale is not necessarily more economical than that on a small scale, neither are small units of production necessarily inefficient, out of date, and out of fashion. In both matters there is dependence upon circumstances. As compared with small-scale production, large-scale production may claim certain advantages, and *vice versâ;* but the weight of these advantages in either case differs

widely in individual instances. There is no "necessarily" in the matter at all. With Mr. Fox, we believe that the unit of moderate size will survive, inasmuch as it may be possible for it to embrace advantages claimed for both large and small units of production. Dealing with competitive industrial undertakings, this is how he puts his case: "The problem of successfully operating a large unit may prove in practice more difficult than would have proved the problem of rehabilitating the constituent members of the unit whose condition of distress was the primary cause for amalgamation. On the other hand, of course, time has proved the success of the policy of undertakings growing larger by gradual expansion and absorption of smaller units, particularly where considerations of trade have dictated the expansion. But units which have grown suddenly large through amalgamation, aiming primarily at elimination of competition, would seem to have a more difficult task in front of them."

There are other suggestive features of the address, drawn from Mr. Fox's own business experience.

PERSONAL

Among those recently elected to Fellowship of the Chartered Institute of Secretaries, we observe the name of Mr. J. R. W. ALEXANDER, M.A., LL.B., Secretary of the Institution of Gas Engineers.

* * *

Mr. ERIC WILLIAMS, who left the Ormskirk and District Gas Company a few days ago to take up his duties as Assistant Manager to the Slough Gas and Coke Company, has been presented with a complete set of drawing instruments by the staff and employees of the Ormskirk Company.

* * *

Mr. H. SPENCER, for the past five years Assistant Engineer and Manager to the Barnoldswick Urban District Council Gas Undertaking, has been appointed Engineer and Manager in succession to Mr. J. P. Thompson, newly-appointed in charge of the Gas Department at Newbury (Berks). The appointment dates from Dec. 1, when Mr. Thompson commences at Newbury. Mr. Spencer, a native of Nelson, was educated at Woodhouse Grove School, near Leeds, and served his articles with Mr. D. Kerry, a former Gas Engineer at Nelson. Subsequently he joined the engineering staff of West's Gas Improvement Company, of Manchester, and superintended the erection of gas installations at Montrose, Falkirk, and other places. Mr. Spencer is a member of the Manchester District Junior Gas Association and holds the certificates for Gas Engineering and Gas Supply and a fuels course diploma of the Manchester College of Technology.

OBITUARY

MR. F. E. COOPER.

Mr. F. E. Cooper, an announcement of whose death appeared in the "JOURNAL" last week, was born in 1860, and after serving his articles of clerkship with his father (Mr. R. W. Cooper), he was admitted a Solicitor in March, 1888. He was head of the firm of R. W. Cooper & Sons, Solicitors and Parliamentary Agents; and Secretary, since its foundation in 1898, of the Gas Companies' Protection Association.

Deceased was a keen Freemason; he held London Rank in the Craft, and London Chapter Rank (R.A.). He was initiated in 1903 in the Aldersgate Lodge, No. 1657 (W.M. in 1910); a Founder and 6th Master (1911-12) of the Wantage Lodge, No. 3178; and a member of the Correspondence Circle of the Quatuor Coronati Lodge, No. 2076. In the Aldersgate Chapter (R.A.), No. 1657, he was First Principal in 1911-12, and again in 1925-26; and was appointed D.C. of the Chapter, for a sixth successive term of office, only three days before his death. He was also a Founder of the Anglo-Colonial Chapter, No. 3175; and a Founder of the Wantage Chapter, No. 3178 (First Principal in 1915); and was advanced in St. Mark's Mark Lodge, No. 1.

He was a Freeman (by patrimony) of the City of London, a Liveryman of the Worshipful Company of Makers of Playing Cards, and a member of the Guild of Freemen. He leaves a widow and one son (his partner in business and Assistant Secretary of the Gas Companies' Protection Association).

THE NEWS OF THE WEEK

Oldham Derived Considerable Benefit from the display of gas appliances at the local Ideal Homes Exhibition. Mr. Parry, Commercial Superintendent, reported to the last meeting of his Committee, that the sales for the past fortnight at the showroom and the exhibition amounted to £511.

Engineer and Manager Required.—As will be seen from our advertisement columns, the Leicester City Council invite applications from qualified gas engineers for the position of Engineer and Manager to the Gas Undertaking. The salary offered is £1500 per annum, and the duties will commence in June, 1933.

Over 250 Persons attended the opening dance of the Birkenhead Gas Department Social and Sports Club, those present including Mr. J. Hood, the Gas Engineer, and Mrs. Hood, Councillor A. Boyd, Deputy-Chairman of the Gas Committee, Mr. J. L. Robson (Assistant Secretary of the Sports Club), and Mr. H. Hall.

Southern Association.—A General Meeting of the Southern Association of Gas Engineers and Managers will be held on Wednesday, Nov. 16, at 2.15 p.m., at the Hotel Metropole, Northumberland Avenue, to elect officers and new members, and to discuss two papers which are to be presented—namely, "Rental Office System in a 300 Million Works Employing Accounting Machinery," by Mr. F. C. Sale, of Ramsgate; and "Benzole Recovery," by Mr. F. Blackburn, A.M.Inst.C.E., A.M.I.Mech.E., M.Inst.Gas E., of Devonport.

North of England Auxiliary Association.—The 25th half-yearly meeting of the Auxiliary Section of the North of England Gas Managers' Association will be held in the Gas Offices, Newcastle-upon-Tyne, at 2.30 p.m. on Saturday, Dec. 3. A paper will be read by Mr. B. Richardson, of North Shields, entitled "Random Topics."

The Institution of Chemical Engineers' Examination, 1933.—Application forms (returnable by Dec. 19, 1932) and particulars of the Associate-Membership Examination for 1933, together with the memorandum on "The Training of a Chemical Engineer," may be obtained from the Hon. Registrar, Institution of Chemical Engineers, Abbey House, Westminster, S.W. 1.

The Successful Gas Cookery Lectures given at the Ipswich Gas Company's Lecture Hall came to an end on Friday, Oct. 28. Following Thursday's demonstration of cooking a complete dinner for less than 2d., on an automatic gas cooker, the chief event on Friday was the announcing of the result of the free cake-baking competition held in connection with the lectures. Competitors were invited to submit for competition a walnut cake made to a set recipe. The entries reached the formidable total of 177. The Judging Committee consisted of Miss M. K. Gompertz, M.C.A. (the demonstrator), with Mr. Harris, Chef, and Mr. Vyse, Assistant Chef, from the Ipswich Picture House. At the end of the afternoon lecture, Mr. G. A. Mallett, the Secretary of the Ipswich Gas Light Company, announced the result.

THE NEWS—*continued.*

"Punch" Almanack.—This publication—the first of the Christmas Annuals—draws attention to the near approach of the festive season. The issue is predominantly pictorial, with a large section in full colour, and contains dozens of humorous pictures and scores of jokes. All the leading "Punch" artists are represented. The Almanack is more than usually seasonable in character, and can be recommended as really excellent value. It costs 1s.

Written Contributions to the Discussions on the Reports presented at the 4th Autumn Research Meeting of The Institution of Gas Engineers should be submitted, in quadruplicate, to the Secretary of the Institution not later than Thursday, Nov. 17, when they will be circulated to authors. The authors' written replies to the verbal discussions at the meeting and to the written contributions should be sent, in quadruplicate, to the Secretary not later than Thursday, Nov. 24.

Imperial Continental Gas Association.—With a view to diminishing the difference in rate between the interim and final dividends for the year, the Board of the Imperial Continental Gas Association have decided that, out of the profits for the half-year ended Sept. 30, 1932, an interim dividend at the rate of 5% (actual) on the £5,600,000 capital stock of the Association be paid, less income-tax, on Nov. 29, 1932. The Transfer Books of the Association will be closed from Nov. 9 to 19, 1932, both days inclusive.

Deputation on Municipal Expenditure.

On Monday of last week a deputation representative of industrial and commercial interests in South Wales and Monmouthshire interviewed the Parliamentary Secretary to the Ministry of Health (Mr. Geoffrey Shakespeare) in London, on the subject of municipal debt and expenditure. Mr. H. D. Madden, Engineer and Manager to the Cardiff Gas Light and Coke Company, represented the Gas Industry.

Mr. Madden gave figures relating to the burden of taxation which affects the costs of gas in a number of heavily rated towns in the South Wales and Monmouthshire area, indicating that if this burden could be reduced, the cost of gas would be reduced to the benefit of the cottage home consumer, who relies upon it for lighting, cooking, and heating. A reduction in price would cause more gas to be sold and more coal would have to be raised, giving work to the miners, and incidentally to the Railway Companies in the conveyance of coal, residuals, &c.

Institution of Gas Engineers.

Beit Fellowship for Scientific Research.

Applications for the Beit Fellowship for Scientific Research—which were founded and endowed by Otto Beit, Esq. (London), in 1913 "to promote the advancement of Science by means of Research"—must be received on or before April 13, 1933. Copies of the conditions of the award and the form of application may be obtained by members or the research staff of the Institution of Gas Engineers from the Secretary of the Institution, at 28, Grosvenor Gardens, London, S.W. 1.

Not more than three Fellowships, each of the annual value of £250 and tenable for a period of two years, will be awarded on or before July 14, 1933, to candidates, under the age of 25 years, who "are of marked promise and are likely to become researchers above the average."

The Beit Scientific Research Fellows work for the whole of their time under the supervision of a Professor of a Department of the Imperial College of Science and Technology, and must not, without permission, take or hold any appointment whether paid or unpaid. Applicants have to state the general character of the research which they propose to carry on, but the Trustees specify the work of research which they are authorized to carry on.

Every Fellow shall be a person, man or woman, of European descent by both parents, but otherwise of any nationality whatsoever, who at the date of election shall have taken a degree in any Faculty in any University in the British Empire approved by the Trustees, or have passed the examinations which would have entitled him or her to take any such degree, or is in possession of any Diploma or Associateship of any College approved by the Trustees.

Publications Received.

The following publications have been received from the Bureau of Mines of the United States Department of Commerce, and may be inspected in the Library of the Institution of Gas Engineers.

Removal of Soot from Furnaces and Flues by the Use of Salts or Compounds. (Bulletin 360.)

Clinker Formation as Related to the Fusibility of Coal Ash. (Bulletin 364.)

The following publications have been received from the American Gas Association, and may be inspected in the Library of the Institution of Gas Engineers:

"A Study of the Characteristics of Burning Gas with Preheated Air." (Report No. 685.)

"Standard Nomenclature for Industrial Gas Combustion Systems." (Report No. 694.)

"Research in the Elimination of Noise in Industrial Gas Burners." (Report No. 692.)

Sir Francis Goodenough and the "Principles of Commerce."

By arrangement with the Southgate Chamber of Commerce, under the Chairmanship of Mr. C. Stanley Brown, F.F.A.S., Sir Francis Goodenough, C.B.E., delivered an address on Oct. 31 on the "Principles of Commerce," at Selborne Hall, Southgate.

During the course of his remarks Sir Francis dealt with trading and marketing as vital to the progress of the country as a whole, and urged that trading should be conducted on sound principles and put into practice by thoroughly qualified personnel. Business must be conducted for the mutual benefit of the buyer and seller and on lines of service to the community and the individual customer and for the profit of the person who buys as well as him who sells, otherwise permanent prosperity cannot be attained. The word of the business man should be as good as his bond and his performance better than either. Punctuality in performance is necessary if trouble is to be avoided, and care should be taken in the making of promises.

The importance of the customer was emphasized, and the fact that he may be poor should encourage traders to do business with him, as in the last analysis the customer is the employer, and it is essential that this fact should be made patent to the staff.

At the conclusion of the address a lively discussion ensued, and Sir Francis was thanked, on the proposition of the Vice-President, Mr. A. Home Morton, M.Inst.C.E., seconded by Mr. H. G. F. Gamble, and supported by Mr. S. B. Chandler, M.Inst.Gas E., a Past-President of the Chamber, and Distribution Superintendent to the Tottenham and District Gas Company.

Forthcoming Engagements.

Nov. 12.—WESTERN JUNIOR ASSOCIATION.—Meeting in Bristol. Address by Mr. R. E. Gibson.

Nov. 15.—B.C.G.A. SESSION at Royal Agricultural Hall. Paper by Sir Leonard Hill at 3 p.m.

Nov. 16.—B.C.G.A.—Meetings of Executive Committee, 11.30 a.m.; General Committee, 2.30 p.m., 28, Grosvenor Gardens, S.W. 1.

Nov. 16.—SOUTHERN ASSOCIATION.—General Meeting, Hotel Metropole, London, W.C., at 2.15.

Nov. 29.—INSTITUTION OF GAS ENGINEERS.—Meeting of Gas Appliances Sub-Committee, 2.30 p.m., 28, Grosvenor Gardens, S.W. 1.

Nov. 29.—SOUTHERN ASSOCIATION (EASTERN DISTRICT).—Meeting at 28, Grosvenor Gardens, S.W. 1, at 2.30 p.m.

Dec. 3.—NORTH OF ENGLAND AUXILIARY.—Meeting at Newcastle-upon-Tyne. Paper by Mr. B. Richardson.

Dec. 12.—INSTITUTION OF GAS ENGINEERS.—Meetings of Joint Research Committee, 10 a.m.; Liquor Effluents and Ammonia Sub-Committee, 12 noon; Finance Sub-Committee, 2 p.m.; Finance Committee, 2.30 p.m.; Executive Committee of the Council, 3 p.m.; Purifiers Sub-Committee, 5 p.m., 28, Grosvenor Gardens, S.W. 1.

Dec. 13.—INSTITUTION OF GAS ENGINEERS.—Meetings of Council, 10 a.m.; Education Executive Committee, 4 p.m., 28, Grosvenor Gardens, S.W. 1.

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Page 6. BARNOLDSWICK. Mr. H. Spencer appointed Engineer and Manager vice Mr. J. P. Thompson.

Page 48. NEWBURY. Mr. J. P. Thompson appointed Engineer and Manager vice Mr. L. J. Weaver, resigned.

Renovation of Gas Cookers.

New De-Greasing Plant.

A practical and efficient method of cleaning "exchanged" and "brought-in" gas cookers is made available to gas undertakings by an adaptation of the I.C.I. de-greasing plant that has already proved so successful in the motor, textile machinery, and other engineering trades. The new model is known as "Type D."

Hitherto the renovation of cookers for re-issue to the public has involved such laborious cleaning processes as sand blasting, caustic soda baths, and even scraping. By the new method all that is necessary is to strip the cooker of all removable parts, remove the slag wool, and load the main body of the cooker and all the parts except the slag wool into the plant. After five minutes it can be raised out absolutely free from all grease, and dry. As many as half-a-dozen cookers can be put in at a time if desired.

Imperial Chemical Industries offer gas undertakings and stove shop managers the advice of their Technical Staff on new methods of removing grease and carbon.

Oil-Coal as Boiler Fuel.

In connection with the recent discussions in this country on the use of a mixture of coal and fuel oil ("colloidal fuel") as a boiler fuel, some interesting results have recently been obtained in Germany. A number of boiler tests have been carried out by the Maschinenbau A.G. Balcke, of Bochem, using a fuel consisting of a mixture of 55% powdered coal and 45% tar oil. This was burnt in an ordinary steam expansion burner without any preliminary heating and good combustion was obtained without the production of smoke. A high thermal efficiency—viz., 81%—was obtained, while the evaporation per sq. ft. of heating surface equalled 5·5 lbs.

No information is available regarding the type of boiler or the method of preparation of the fuel, but the experiments seem to have been regarded as quite successful, and form an interesting commentary upon the suggestion previously made in the "JOURNAL" that the coal-oil fuel process should be carefully examined as an outlet for coal tar oils.

Creosote Oil for Motors.

A special representative of the Australian Government has visited Belfast Gas-Works to make a study of the manufacture of creosote oil as substitute for petrol, and to test its efficiency in the engines of 'buses and motor-cars. He was received by Mr. J. D. Smith, the Manager, with whom he consulted on the subject. He also visited the depôt of the Belfast Omnibus Company, who have successfully run twelve 'buses on the new fuel, and who propose to convert a further number of these vehicles to its use. It is stated that the representative was highly impressed.

The composition of the new fuel has been widely distributed by Mr. Smith in response to inquiries from all parts of the world. The London General Omnibus Company, in collaboration with the Belfast authorities, are, we understand, carrying out extensive tests; and it is believed that in the near future some of their 'buses will be converted.

The fuel, which is being successfully used in private motor-cars in Belfast, is sold at an average cost of 6d. a gallon. Tests and experiments are still being made with a view to achieving perfection.

Cookery Demonstrations at Maidstone.

The showrooms of the Maidstone Gas Company were packed to their fullest capacity on Oct. 7 for the prize distribution in connection with the baking competition organized by the Company during their gas cookery lectures and demonstrations held during the preceding week under the instruction of Miss E. Kirkby, Chief Lecturess of Radiation Ltd.

The first prize of an "Era" New World cooker, in enamel finish with "Regulo" control and plate-rack, went to Mrs. E. M. Hills, 24, London Road, Maidstone, and it was rather a coincidence that her winning cake was baked in an oven similar to the prize. The second prize, a seven-radiant gas fire in lustre finish, was won by Miss F. Garratt, 33, Hastings Road, Maidstone. The winner of the third prize, an enamelled gas iron and stand complete with 6 ft. of tubing, was Mrs. Howard, 17, Lower Stone Street, Maidstone. Fourth prize, a gas poker for fire lighting, was awarded to Mrs. Moreton, 185, Boxley Road, Maidstone.

In welcoming the ladies present, Mr. F. Livesey, Engineer and Manager of the Maidstone Gas Company, said it was the unceasing desire of the Company to give good service to the housewives of Maidstone and district, and much would be done in this way by providing gas of a regular quality and at a regular pressure. Next in importance was the service the Company rendered, and they did everything in their power to train up young men to be skilled workmen and efficient and polite in their dealings with the public with whom they were constantly in contact. The Company's desire was to see gas used more economically and to see kitchens brighter and more cheerful. The type and appearance of modern gas cookers assisted in this object. There were other ways of cooking than by gas, he added; but gas was, and would remain, supreme.

Mr. R. G. Bergg, the Showroom Manager, presented the winning ladies with sealed envelopes containing the value of the prizes.

Ministry of Health Inquiry at Oldham.

With the object of providing gas water-heaters on a rental system in smaller homes, the Oldham Gas Committee have applied to the Ministry of Health for sanction to borrow £15,000.

This formed the subject of a Public Inquiry at Oldham. The Town Clerk stated that for some time past there had been a demand for a small water-heater suitable for fixing in houses which at the present time are without any means of providing a supply of hot water other than by heating kettles on the fire or gas cooker, &c. Instead of charging the costs to the consumers, the Council may instead charge them with rent.

The Gas Committee has entered into arrangements with certain firms for the supply of heaters of two or two and a half gallons capacity with flat flame burners, from £2 5s. to £3 5s. 3d. each, and in addition there was the cost of fixing, which averaged about 25s. per appliance. The rental which it was proposed to charge for the heaters would vary, according to type, from 1s. 9d. to 2s. a quarter. Orders were coming in at the rate of eighty to one hundred a week, so the Committee had decided to treat the provision of these heaters as a separate branch of the Undertaking.

Mr. Ernest Parry, Commercial Manager of the Gas Department, informed the Inspector that there were over twenty thousand gas coppers for washing in use in the district, but gas boilers for domestic water supply were not used to the same extent. Eleven hundred heaters had been installed since August. Although the Committee did not buy the heaters by tender, there was no question of any monopoly for particular firms.

Wandsworth Company's New Collier.

The largest cargo of coal that has ever passed through London Bridge was brought to Wandsworth on Sunday, Oct. 30, 1932. The ship, the new S.S. "Wandle," that established a new record for the Up-River, belongs to the Wandsworth and District Gas Company. She is a successor of the famous S.S. "Wandle," the collier of 1200 tons cargo, that successfully fought a German submarine in the North Sea, in April, 1916. The new S.S. "Wandle" brought to Wandsworth on Sunday last 2300 tons of coal from Sunderland.

The "Wandle" is 236 ft. long, 38 ft. wide, and 16 ft. 5 in. draft. One of the outstanding features of the ship is her tractability. Although she is 236 ft. long and 38 ft. wide and is pushed through Waterloo Bridge, including the "ramifications," by engines that develop about 11 knots, yet she responds to the slightest touch of the helm and can be made to swing round in practically her own length. When she was passing through Waterloo Bridge and had to take the bend of the River, the Pilot, Captain W. G. Lockey, had her "tail" straight opposite the supporting columns just after emerging from the arch shadow, demonstrating that she can be manœuvred as easily as if she were a pleasure motor launch.

The new steamer is a sign of the returning confidence in the future of industry on which the progress of the country is based, and the additional carrying capacity of the "Wandle" will help towards keeping down the cost of living by maintaining the low prices of gas which have been a "hall-mark" of the Wandsworth and District Gas Company since it was first established nearly 100 years ago.

The S.S. "Wandle" was built by the Burntisland Shipbuilding Company and engined by the North-Eastern Marine Engineering Company.

THE "JOURNAL" REVIEW

Of the Institution Research Meeting. A Full Report Follows.

The Hall of the Institution of Mechanical Engineers was well filled when, on Tuesday morning, Nov. 1, the President of the Institution of Gas Engineers, Mr. Ralph E. Gibson, of Liverpool, welcomed those present to the fourth Autumn Research Meeting—a conference which from beginning to end was characterized by the keenness, high standard, and utility of the discussions on the research reports presented.

Progress of the Education Scheme.

The first report to be discussed was that of the Education Committee for 1931-32, which was presented by the Chairman, Sir Francis Goodenough. As our readers are aware, the Education Scheme of the Institution was entirely revised in 1929; and experience gained since then has enabled a further revision to be made during the year covered by the report. The basis of the Scheme remains the same, but there is a fundamental alteration in that the Diploma in Gas Engineering (Supply) has taken the place of the Diploma in Gas Supply, and will admit to Corporate Membership of the Institution, if the other necessary conditions are fulfilled. Candidates may continue to take the Diploma in Gas Supply at the Examinations in 1933, 1934, or 1935, and holders of that Diploma may apply to have it converted to the Diploma in Gas Engineering (Supply), if the additional ancillary subjects are presented not later than June 30, 1935. Another change is that the duration of the Minor Course in Gas-Works Practice has been increased from two to three years, to conform with the Minor Course in Gas Supply Practice. There is now no restriction as to the age of candidates for the Final Grade Examination in Gas Fitting.

Concerning the 1932 Examinations, there was a gratifying increase of 37% in the number of candidates examined —and an interesting fact is that candidates sat for the Examinations in New Zealand and South America, as well as at Centres throughout Great Britain. In regard to the Minor Courses in Gas-Works Practice and Gas Supply Practice and in Gas Fitting, the number of candidates for the Examinations in Gas Supply Practice and Gas Fitting shows an increase of 37% and 35% respectively over the preceding year. Altogether it would appear that gas engineers and managers are encouraging members of their staffs to take the educational courses available; but the employees of gas contractors have not yet entered for the Examinations to any appreciable extent.

"An Outstanding Example."

Introducing the report Sir Francis emphasized the importance of co-operation between industrialists and educationists. In this respect he expressed the opinion that the Gas Industry is an outstanding example of adequate co-operation between the Industry on the one hand and the educationists on the other; and in this connection he referred to the great services rendered to the Industry by Mr. A. Abbott, of the Board of Education. "I should," he said, "like the Institution to place on record its appreciation of the valuable services which Mr. Abbott has rendered to the Education Scheme from its very inception, and the valuable part that he has played in being the chief liaison officer between the Institution and the Board of Education and the educational authorities throughout the country." Sir Francis also paid tribute to the good work done by Mr. C. H. Creasey, by the Board of Examiners, and by Mr. Alexander, the Secretary of the Institution.

In a speech which was listened to with great interest Mr. Abbott referred to the Industry's lead in planning the Educational Scheme from the regional point of view as distinct from the point of view of single local authorities; and he praised the Industry's endeavour to satisfy the needs of the craftsman.

Both Mr. Terrace and Mr. Lacey, while congratulating the Education Committee on the substantial increase in the number of candidates for examinations, suggested that the present numbers are not yet anything like large enough. "Do you think," asked Mr. Lacey, "that an annual addition of about 150 salesmen holding Ordinary Grade or Minor Course certificates is sufficient?" His opinion on this matter is obvious from his remarks; and he believes the fault is due to lack of encouragement by those responsible. The Ordinary Grade Certificate for the Major Course, he said, should be looked upon as the minimum standard of educational knowledge for all salesmen; and in common with Mr. Cannon he sets great store by general education as a necessary foundation for specialized study. In his reply Sir Francis also emphasized this point. "The secondary schools and the public schools of this country," he observed, "are producing a large flow of really well-educated young men, well grounded in general education, of whom the Industry might make better use than it does, by offering better prospects of pay and promotion than are offered at the present time."

New Diplomés and Medallists.

Then came the presentation of Diplomas—a happy and satisfactory feature being the award of two Diplomas in Gas Supply. The successful candidates who obtained First-Class Diplomas in Gas Engineering are: J. H. Dyde, M.Sc., Plymouth (with Distinction); D. Benson, B.Sc., Bolton; C. Johnson, Liverpool; W. O. Kirkwood, Sunderland. Those who gained Second-Class Diplomas in Gas Engineering are: R. W. Harris, Clitheroe; W. B. Harrison, Blackburn; J. W. Pye, Ilfracombe; A. Tran, Coatbridge; J. Webster, Port Glasgow.

In Gas Supply, L. Poulter, London, was awarded a First-Class Diploma, and A. Bujnowski, Glasgow, a Second-Class.

Mr. Dyde was also presented with the Charles Hunt Memorial Medal in the Diploma Examination in Gas Engineering, 1932, and Mr. Poulter with the corresponding Medal in Gas Supply.

Research in General.

In the Report of the General Research Committee, taken next, there is mention that during the year substantial advance has been made in the co-operation of the General Research Committee with gas undertakings and other organizations conducting research and technical work of interest to the Industry, though much remains to be done in the direction of co-ordination and collation. A Gas Appliances Sub-Committee and an Industrial Gas Committee have been appointed, and the work of the Pipes Sub-Committee has been extended. The last-named Committee has tested a number of pipes, wrappings, paints, processes, and devices for which anti-corrosive properties are claimed, and the information so secured is available for the guidance of members of the Institution. British and foreign literature relating to pipes generally, and their protection in particular, continues to be examined, and it is anticipated that a Second Report on the Protection of Pipes against External Corrosion will be presented by the Sub-Committee at the next Research Meeting.

In regard to the work of the Meters Committee, the following resolutions have been passed by the Council of the Institution:

(1) The Institution of Gas Engineers approves the principle of the re-verification of gas meters on the following basis, but is of opinion that the principle should not be applied until provision is made for the verification and re-verification of electricity meters:

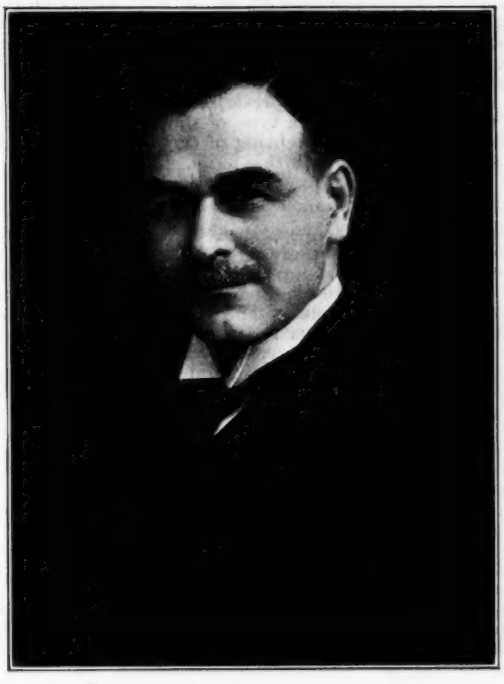
> The basis of re-verification should be that all meters which have not been verified (or re-verified) for over twenty years shall be re-verified within five years, and all meters which have not been verified (or re-verified) for over fifteen years shall be re-verified within ten years of the date of regulations to this effect, and after such period of ten years all meters shall be re-verified within fifteen years of their last verification (or re-verification).

(2) That air only should be used in the absorption of pressure test of new meters.

The Committee is considering if the present bases for the Classification and Rating of Gas Meters should be revised

THE PRESIDENT.

Mr. Gibson is Chief Engineer to the Liverpool Gas Company, the largest of the Company-owned Undertakings in the Provinces, having an annual output of over 8000 million c.ft. of gas. His connection with the Company has extended over a period of nearly 28 years. He joined the Company in 1904, when he was appointed Assistant Engineer. For eleven years he was largely responsible, under the late Mr. Edward Allen, Chief Engineer, for the design and construction of extensive alterations and additions to the manufacturing plant, including a large amount of labour-saving machinery. On the death of Mr. Allen in July, 1915, Mr. Gibson was appointed Chief Engineer, and was responsible for the administration of the Company on the technical side during the difficult period of the war, continuing in that position up to the present time. During this latter period many improvements have been carried out. The carbonizing plant has been modernized throughout, the obsolete works at Caryl Street have been closed down, new coal gas-works have been constructed at Garston, the distributing system has been improved and greatly extended, and two Gas Undertakings have been absorbed—viz., Hightown Gas Company and Woolton Gas Company. One of the latest developments has been the production of the new smokeless fuel "Dryco," by high-temperature carbonization, which was the subject of a paper read by Mr. Gibson before the National Smoke Abatement Society last Autumn. Mr. Gibson is a member of the Institution of Civil Engineers, having previously been a Student and an Associate Member. He was elected an Associate Member in 1900 after passing the qualifying examinations. He was elected President of the Manchester District Institution of Gas Engineers in 1923 and President of the Liverpool Engineering Society in 1924. Mr. Gibson was educated at the Sheffield Royal Grammar School, and received his early training in the Works and Drawing Office of Messrs. Newton, Chambers, & Co., Ltd., where he served a pupil-apprenticeship of six years. He was afterwards engaged for a period of four years on Messrs. Newton, Chambers, & Co.'s staff in designing gas-works plant and other engineering structures, surveying sites, preparing plans, specifications, and estimates, and also in supervising erection. During this time he studied Mechanical Engineering and other subjects at the Sheffield Technical College. In 1899 he was appointed Engineering Assistant to the Huddersfield Gas Department, and for nearly five years was engaged there on renewals, extensions, and general supervision of the manufacturing plant and distributing system. From there he went to Liverpool. He has served on many District and National Committees in connection with the Gas Industry.



RALPH ERNEST GIBSON, M.Inst.C.E.

and if gas meter capacities should be standardized, while the interests of the Gas Industry are being watched relative to a tentative proposal to prohibit the stamping of any gas meter having a pre-setting device, which can be manipulated to cut off the supply of gas by means other than the normal operation of the meter.

There was no discussion on the report, which was presented by the President.

Gasholder Inspection and Insurance.

As Chairman, Mr. Hardie submitted the 1st Report of the Gasholder Sub-Committee, on the problem of inspection and insurance of gasholders. The Committee believes that undertakings should continue to be responsible for the inspection of their gasholders by their own staffs; and schedules of "Periodical and Annual Gasholder Inspection and Maintenance Records" have been drawn up. These schedules were published in the "JOURNAL" for July 20, 1932.

The difference between inspection of gasholders and their insurance is pointed out: Insurance would not ensure the safety of holders; it would merely operate to transfer a financial liability from an undertaking to an insurance company. The insurance companies aim at providing not only for insurance against damage arising from holder accidents—which risk is already largely covered by existing fire and third-party policies—but for the carrying out of an initial and an annual inspection of gasholders insured. But the Committee is of opinion that such a scheme is not generally necessary, having in mind the extreme remoteness of the risk. In any case, should a scheme for inspection-cum-insurance prove attractive, the scheme does not remove the necessity for frequent inspection and maintenance by the undertaking itself, and advantageous arrangements for the annual inspection could probably be made with a third party if and when required, without the necessity for entering into a policy of insurance.

Any insurance scheme is likely to prove more attractive to smaller undertakings than to larger concerns. One insurance company, however, with a view to meeting the possible requirements of the larger undertaking, is prepared to formulate a modified scheme, in cases where gasholders of recent date are under skilled supervision and the inspection of the insurance company would entail unnecessary expense. Another company is prepared to accept the certificate of the gas engineer of the undertaking concerned for the purpose of the insurance of its gasholders. This course is economical and would commend itself to gas engineers who dislike the principle of an inspection from outside—especially when such inspection is carried out by gasholder contractors, subject only to the supervision of the consulting engineer to the insurance company. With insurance on such a certificate, the policy should be free of limitations as to liability if there is any fault in the certificate of the engineer.

The memorandum on insurance in the report is full of sound advice, attention being drawn to the extent to which gasholders are, or could be, covered at normal premiums by existing policies, such as third party and/or fire policies.

Mr. Hardie emphasized the necessity for the regular inspection of holders. "I think," he remarked, "that if we look after the holders ourselves there will be no need for further official regulations in regard to them."

Planning of Street Lighting Installations.

This brought us to the paper by Mr. F. C. Smith, of the Gas Light and Coke Company, which was presented at the Conference of the Association of Public Lighting Engineers in September last, and a lengthy abstract of which was published in the "JOURNAL" for Sept. 21. The paper is an indication of at least two things. In the first place, it shows that the Gas Industry is alive to the fact that gas has nothing whatever to be ashamed of as a modern illuminant; rather that its claims are well founded. Secondly, it demonstrates the value of an organization such as that at Watson House, where a competent technical staff enjoy adequate facilities for investigation. It is a guide to lighting engineers throughout the country; and if those responsible for gas lighting apply the author's advice, there will be little to grumble about in gas.

The paper outlines a method of deciding the type of lamp and orientation of light sources to be employed, while methods are suggested of obtaining the additional information required to be submitted with the tenders. Of this information the most important is the light distribution of the sources employed and the distribution of illumination on the road which would result from their use. The paper includes the results of a number of tests on typical gas lamps carried out in the Watson House Laboratories, together with the results obtained with two new reflectors specially evolved during the work. It also includes a series of curves, plotted from simple formulæ, which enable the candle-power required, and the angles at which it must be

directed, to be read off for any particular arrangement of the lamps. A number of street lighting schemes which have been produced by applying the method outlined in the paper are set out. These would afford practicable methods of lighting streets 30, 40, or 50 ft. wide to levels of illumination represented by Classes C to H of the British Standard Specification for Street Lighting. In addition some information regarding the demonstration Class A Lighting in Whitehall in 1931 is given.

A basis is suggested for prescribing the class of illumination necessary for a given type of thoroughfare. It shows in what degree the gas lighting of certain well-known London streets conforms with this basis.

The B.S.I. Specification.

Introducing his paper, Mr. Smith observed that the lighting of a public thoroughfare in a manner to give general satisfaction is no easy matter. However, if we rely on rule-of-thumb methods the results are bound to lead to disappointment. The B.S.I. Specification, he pointed out, is not to be regarded as an ultimatum; experience will bring improvements. In the meantime it is practical politics that the Gas Industry should thoroughly understand the Specification, and have schemes available so that tenders may be submitted to inquiring authorities; and if an isolux diagram for the lighting of a given thoroughfare is submitted with the tender, it is much easier to assess the relative merits of two schemes. The isolux diagram "is probably the easiest method of representing the distribution of light over the road surface." Mr. Robert Watson, of Doncaster, who has done such excellent work for the lighting load of our Industry, clearly liked the Specification of 1927, with its simple and convenient method of appraisement of street lighting. Unfortunately the safeguards were ignored, and there were attempts, by means of asymmetric fittings, to focus light on the specified test point, to the disadvantage of the road surface. Hence the further stipulation that average illumination should be included in the Specification. "It is perhaps questionable," remarked Mr. Watson, "whether the Specification has been adopted in many contracts to date, but I do not think that matters so long as guidance of the Specification is accepted." It has certainly served a useful purpose in improving existing installations. Many members of the Institution have adopted the suggestions of the Specification, not only to the advantage of the installation itself, in effecting better visibility, but also to their own advantage in meeting competition.

Col. Carr mentioned his difficulty in getting the surveyors in his area of supply even to look at the Specification; and he urged his audience to bring influence to bear on local authorities to adopt it as a basis of tender.

The Back-Run Process.

Tuesday morning's session came to an end with the presentation and discussion of the 2nd Report on the Back-Run Process for the Manufacture of Carburetted Water Gas. The 1st Report on the process, presented at last year's research meeting, contained an account of a test carried out at the Stratford Works of the Gas Light and Coke Company. This has been followed up by more searching tests, which were rendered possible by the Gas Light and Coke Company placing at disposal a carburetted water gas plant which could be worked with or without the back-run, the necessary structural alterations being made by the Company at their Nine Elms Works.

A series of tests has been carried out, and the numerical data obtained from them have been subjected to careful and critical examination, so as to ascertain as far as possible not only what differences existed between the back-run and ordinary down-run processes, but how these differences were brought about. The tests were made on a Humphreys & Glasgow hand-operated unit, with water-sealed generator and automatic ash discharge. The results and conclusions form the substance of the Report, but it may be said at once that the whole matter is so complicated, that if a reader desires to check for himself the reliability of the conclusions arrived at, careful perusal will be necessary of the Appendices in which the tests are considered separately and in detail.

The main conclusion may be stated thus: That owing primarily to the return to the generator of heat convected by the back-run steam from the carburettor and superheater, there is less heat absorbed in the generator for every unit of gas made. There is therefore less heat to be supplied by the gasification of carbon in air during the blow, and a consequent measurable increase in thermal efficiency and output.

In one test the use of back-run steaming increased the efficiency of blue gas production from 50 to 54·2% under conditions in which the make of gas per day was simultaneously increased by 6·7%. By a general lowering of the fuel bed temperature it is probable that the efficiency could have been still further increased if the gain in "make" had been sacrificed, or, *vice versâ*, a still higher make could have been obtained, if the increase in efficiency had not been sought for.

The importance is brought out of the proper distribution of temperature through the fuel bed, and particularly the avoidance of low temperature near the grate, both of which ends are more easily attained in the back-run process. The loss of steam filling the carburettor and superheater and swept away in each cycle at the end of the back-run was not greater than the observed escape past the hot valve in the ordinary down-run. It seems probable that this escape takes place in all valves of this type.

Stress is laid upon the physical nature of the ash produced in the generator, which may be such as to lower the temperature from ash accumulation near the grate, and lessen both efficiency and output, as indicated above.

Among the points of interest noted in the Appendices is one concerning the production of H_2S in the water gas plant. It appears that a considerable proportion of H_2S leaving the generator during the run is absorbed in the carburettor and superheater, from which it is driven off to the chimney during the blow, or returned to the generator during the back-run with steam.

Which Process Should be Adopted?

The discussion on the report was most fruitful; and we now have much clearer conceptions of the relative merits of the down-run and the back-run processes. Making blue water gas, there is little to choose, as regards thermal efficiency, between the two; though the back run may possess the advantages of an increased rate of gas output, decreased labour, and greater uniformity of working. Mr. C. A. Cunnold, Station Engineer at the Nine Elms Works of the Gas Light and Coke Company, definitely prefers back-run steaming for calorific values round about 400 B.Th.U. per c.ft., and claims that he then gets the advantage of a reduced consumption of coke of about 3 lbs. per 1000 c.ft. with an increased output per set per day, but with a reduced output of steam from the waste-heat boilers. On the other hand, when he requires carburetted water gas of a calorific value of 500 B.Th.U. he favours down-run steaming. This idea was supported by other speakers, and appears to us of major significance.

Criticism of Dr. Dent's "laborious means of measuring the gas volumes of cycles" was forthcoming from Dr. J. G. King, of the Fuel Research Station, who showed how, by attention to the fuel-bed conditions in a water gas generator and by working within definite temperature limits, it is possible to increase the process efficiency of water gas production by about 10%. Dr. Parker said he would hesitate to measure the difference between the back run and the down run unless he had the use of some form of positive blower which would deliver a definite volume of air in a definite time. The distribution of the coke (even when carefully graded), and the charactristics of the ash alter the path of flow of the air, as well as affecting the resistance to the flow.

Underground Gases—The Holborn Explosion.

Tuesday afternoon's session was devoted to two reports, the first being one by Prof. Haldane, one of the Gas Referees, on "Gases Met with Underground." He explains what an enormous volume of gas can be contained in pores in solid underground strata; and how, on the application of pressure—either natural or artificial—vast quantities of gas, either combustible or non-combustible, may issue into wells or underground passages. He quotes an interesting case of choke-damp being driven into a building by artificially applied pressure during the construction of the Rotherhithe Tunnel, while compressed air was being used to prevent water from entering through the exposed clay where excavation was proceeding. Another instance to which he refers is the tragedy in the Thames Estuary last year. A caisson, open to the air, and about 30 ft. deep, was being sunk, not far from another caisson in which compressed air was being employed to keep the water out. Gas came up through some water at the bottom of the open caisson, in which four men were working; and they, together with a foreman who bravely went to their rescue, were all suffocated by want of oxygen. The air leaking through the bottom of the neighbouring caisson had lost all its oxygen while it passed along under the ground. It had also picked up a good deal of methane, which must have been formed by anaerobic fermentation. Had the current been slower, the percentage of methane would have been such that an explosive mixture might have been formed with air.

Prof. Haldane analyzes the memorable Holborn Explosion of 1928. The case for the Post Office was that it was impossible to account for the explosive gas except

AT THE
RESEARCH MEETING
AS SEEN
by
Fred May

through an escape of coal gas, and that on previous occasions a Short's indicator had detected coal gas in the tube. The case for the Gas Light and Coke Company was that no smell of escaping gas had been noticed anywhere along the street before the explosion; that no appreciable leakage could be found in any main left intact after the explosion; that the smell noticed by the workmen was, with one exception of an inexperienced man, described by them as that of "sewer gas," meaning by this a smell suggestive of putrefaction; and that consequently they did not suspect any danger of explosion. It appeared, therefore, that the gas might have been due to anaerobic fermentation in the soil in consequence of leakages from old drains, &c., and the airtight roadway and foundations preventing oxygen from diffusing down.

During the night preceding the explosion, the change in barometric pressure was such that large volumes of gas might have been driven into any underground space communicating with the open air; and this gas might well contain combustible gas from anaerobic fermentation. The Commissioners, in their report of the explosion, pointed out that it would have taken about 2000 c.ft. of anaerobic fermentation gas to produce the explosion—in which connection, however, Prof. Haldane mentions that with a rise of 0·4 in. of barometric pressure an inflow of 12 million c.ft. occurred into a well in Northallerton. Combustible gas may be present in the subsoil in large amounts under anaerobic conditions, and may find ready vent through an open excavation rather than directly to surface.

As to the evidence of the Post Office that coal gas had been found previously in the tube, Prof. Haldane distrusts entirely the apparent evidence obtained by applying the Short indicator to the keyholes of manholes after removing the airtight stuffing. The Short indicator is practically an indicator of the hydrogen in coal gas. It therefore does not distinguish between coal gas and hydrogen from other sources. "I can see no justification," states Prof. Haldane, "for the definite conclusion of the Commissioners that the explosion was due to coal gas rather than gas from anaerobic fermentation. . . . While the fear that the actual source of the gas which exploded in the Holborn accident will never be settled conclusively, I hope that future research will throw light on how far anaerobic conditions exist in subsoil and give rise to anaerobic fermentation on a large scale when organic matter is present."

New Light on "Gas Escapes."

The first speaker in the discussion, Mr. E. V. Evans, bearing in mind the college boy who started his Greek paper by stating that Homer was much to be congratulated upon his Iliad, did not presume to congratulate Prof. Haldane on his report. Mr. Evans spoke of unfriendly bacteria. In rivers and streams there exists an organism which is capable of absorbing sulphates in ordinary water and evolving in their stead hydrogen sulphide. This fact has caused gas-works chemists many sleepless nights. If holder water becomes infected with this disease—and this bacillus grows and multiplies at an enormous rate—matters become troublesome. However, the means of dealing with hydrogen sulphide production are now established. The organisms consume the sulphates of the water, and the process adopted by the South Metropolitan Gas Company is to let them get on with the good work until they have absorbed the sulphates, and to keep in hand the hydrogen sulphide evolved, by the use of colloidal zinc or zinc acetate.

Mr. Stephen Lacey having referred to a new leakage indicator, developed at Watson House, which gives a definite test for carbon monoxide, mentioned a recent and clear case of anaerobic fermentation in the Gas Light and Coke Company's area of supply. An escape of gas into a cable box was reported at Pinner in June last. No leakage could be found on the mains and services in the vicinity, although searcher holes showed definite indications of gas when tested with a leakage indicator. A ditch had existed at the side of the road, but had been filled in, pipes being laid to convey the drainage. An analysis of the gas aspirated fom the searcher holes showed that this consisted principally of methane and nitrogen, and was undoubtedly due to anaerobic formation. Mr. Hollings also described an occurrence of an inflammable gas underneath a pavement. This gas was produced by fermentation underground in considerable quantities; and the samples taken, with a proper proportion of air, would be definitely explosive; and they were erroneously believed to contain coal gas. In connection with the Holborn explosion, the work of the Gas Light and Coke Company showed that by fermentation gas could be produced containing hydrogen rather than methane as the distinctive constituent. This indicates the necessity for searching for hydrogen as well as methane in circumstances under which gas may be produced by anaerobic fermentation.

The suggestion was put forward by Dr. Lessing that the iron compounds of coal (apart from the organic substances in the soil) may be responsible for the abstraction of oxygen from the air, and in that manner be at least a contributory cause of the formation of choke damp. Also they may influence, catalytically or otherwise, the absorption of oxygen by the organic substances themselves.

Asked whether the presence of carbon monoxide is presumptive evidence of an escape of coal gas, Prof. Haldane said that the presence of very small quantities of carbon monoxide does not prove the presence of coal gas; on the other hand, if there is a good deal of carbon monoxide, one may be fairly sure that there is coal gas about.

Effluents and Crude Liquor.

The final item for discussion on Tuesday was the 2nd Report of the Liquor Effluents and Ammonia Sub-Committee, which gives a very useful general account of the various matters which have engaged the attention of the Committee and its predecessors during the past six years, and which indicates in no uncertain manner the excellent work which has been, and is being, accomplished on the problem. The practical advice afforded should be acted upon; and good purpose may be served if we select a few items from the summary of the report which was published in our Special Supplement on Oct. 26.

The oxygen absorption of spent liquor—and this applies also to ammoniacal liquors—is due to phenols, higher tar acids, thiosulphates, and thiocyanates. The source of these bodies is the tar which condenses with the liquor, and they can be eliminated almost completely from the liquor by the separation of the tar from the gas while above the dew-point. Electrostatic precipitation is the most effective, but good results are given by cyclone tar extractors, and hot liquor sprays in the foul main. Liquor used in the retort house must not be mixed with the rest of the liquor, and as far as practicable condensation of liquor in the retort house should be prevented.

Phenols are not so objectionable as the higher tar acids, and are easier to remove from the liquor. The most popular removal process is washing with benzole and recovery of the phenols. At present only one plant is in operation in this country, though more are contemplated. Another solvent is tricresyl phosphate. Investigation has shown that the initial efficiency of tricresyl phosphate is much greater than that of benzole, and its total capacity for phenol eight times that of the lighter solvent. In addition, thirty times the quantity of higher tar acids is removed. The phenols recovered from the tricresyl phosphate are of better quality than those obtained from benzole, but there is reason to fear that the solvent would deteriorate with continued use, even if vacuum distillation were employed for the recovery of the phenols. The difficulty seems to be that distillation does not recover the higher tar acids, which tend to decompose in the solvent, rendering it more viscous and therefore less suitable for washing purposes. To arrive at a definite decision as to which solvent is the more economical to use it would be necessary to compare full-scale plants working on English gas liquor. The greatest single factor operating against tricresyl phosphate is the initial cost of solvent.

The use of tar oils as solvents is worthy of further investigation.

As to thiocyanate, the formation of this compound can be minimized by reducing the quantity of oxygen in the gas or reducing the time of contact of the gas with liquor. When the gas is passed through tower scrubbers where it is in contact with liquor for upwards of three minutes, the amount of thiocyanate formed is very much greater than when the gas is washed in rotary scrubbers where it remains only a few seconds. Washing the gas with liquor rather than with water also has the effect of increasing the thiocyanate content of the liquor.

On the thorny problem of recovery of ammonia the Committee feels that the policy of destroying liquor is not wise, and that the Gas Industry should endeavour to maintain its position in the sulphate of ammonia market. It is considered that the present price of sulphate is artificially low. Moreover, the production of concentrated liquor has now been made an entirely automatic process, the cost being no more than, if as much as, that of several processes for the disposal of ammoniacal liquor which have come before the notice of the Committee. Again, an investigation is being made of a process for the manufacture of ammonium bicarbonate. Plot trials of its fertilizing effect on wheat and potatoes are now in progress, and preliminary reports are satisfactory.

Part of the report deals with the effect of changing-over from spent to crude liquor. It does not follow in every case that a sewage works which can deal with spent liquor can treat the corresponding amount of ammoniacal liquor. There seems, however, to be no reason why those in authority at a sewage works which already treats spent liquor should refuse to make a trial with ammoniacal

liquor, provided that all parties agree to abide by the result of the test. Sewage works cannot be compared quantitatively with one another. An extended test with both spent and ammoniacal liquors should be carried out before coming to any conclusion as to whether they can be dealt with successfully or not. It is impossible to say definitely in advance what results such a test on any particular works would yield.

The Proper Place for Treatment.

In the discussion, most speakers favoured the idea that the proper place for the treatment of effluent is the sewage works. Mr. A. L. Holton, of Manchester, however, takes the view of Dr. Fowler that liquor effluent should be treated either totally or partially at the gas-works. Mr. Holton's opinion of the merits of tricresyl phosphate as a solvent is well defined—that it is not a practical proposition. Mr. Botley, however, reminded the meeting that the question of the method of disposal of liquor or effluent depends largely on the size of a works; and what can be done at Partington cannot be accomplished in many smaller works. "We have never pretended," he said, "that we could deal with liquor at the same cost as that of dealing with ordinary sewage, but we do expect to have facilities for our trade effluent in any town where we are large ratepayers. It is only right that we should recognize wherever possible—and in many cases we are very pleased to recognize—that there is some additional cost. Obviously, the liquor can be dealt with more economically and better at the sewage works than at a special plant in a small gas-works, where the cost of purifying liquor would be out of all proportion. To-day we can dispose of, and are disposing of, liquor to sewage works with the greatest possible facility where conditions are suitable, and even where the activated sludge system is used."

The rôle of ammonia in biochemical oxidation was referred to by Mr. F. R. O'Shaughnessy and by Dr. F. C. Happold; and Mr. D. C. Cross explained how at Lea Bridge, by the installation of a concentrated liquor plant, he has practically halved the cost incurred when disposing of the liquor in the crude form.

Dr. Monkhouse made the pertinent point that there are cases where the ammoniacal liquor discharge does not take place in a "trunk" sewer, but into a subsidiary one. If the flow of sewage is small, the concentration of ammoniacal liquor in that particular sewer may be high; and if also, as is some times the case with antiquated sewer systems, the drains are untrapped, there is the danger of the fumes of ammoniacal liquor getting back into the house. This, of course, can be avoided by ensuring that the point of entry is into a sewer where there is considerable dilution and that the sewer and its connections are sound.

Mr. Canning Presides.

It will be remembered that at the last autumn research meeting Mr. Canning, who at that time was President of the Institution, was unable to be present owing to indisposition; and it was a gracious act of Mr. Gibson to request Mr. Canning to take the chair during the session on Wednesday morning last.

Before commencing the technical business, the report of the ballot for the election of Members, Associate Members, and Associates of the Institution was received. A list of those elected will be found on a later page of this "JOURNAL."

Radiant Energy from Coal Gas.

Dr. Harold Hartley's report on "The Conversion of the Potential Energy of Coal Gas into Radiant Energy" was the first item for discussion on Wednesday morning. The report deals with the emission of infra-red energy by the bunsen type of flame and the changes which can be effected by the insertion of solid bodies in the flame, or by the use of radiants as in the gas fire.

Regarding the direct radiation of energy by the flame itself, the structure of the compound flame is first examined. Attention is drawn to the fact that the outer sheath is of wavy form so that the limits of visible combustion are not sharply defined. The heat radiated by the hot products passing away from the visible outer cone provides the major portion of the total radiation from the flame. There are three other possible sources of the flame radiation—namely, the outer and inner visible cones, which are sheaths of flame, and the inter-conal gases.

The composition and thermal intensity of the gases leaving the inner cone for different primary-air/gas ratios are calculated. It is computed that these gases have a thermal intensity corresponding to 2950° F. for an air/gas ratio of 2·4, and 3500° F. for an air/gas ratio of 3·4. [Gas of 500 B.Th.U.]

The relative magnitude of the emission by the four sources mentioned is considered, and the proportions of the energy radiated from within and without the outer cone are deduced. It would appear that about 85% of the total radiation comes from the hot products without the flame.

The effect is discussed of inserting a solid in the inter-conal gases on the quality and quantity of the energy radiated. The extent of the increase in the emission is determined by the surface properties of the substance used, which also influence materially the quality of the energy radiated. The possibility of further chemical reaction of the inter-conal gases in contact with the solid is considered, and it is shown that the input of energy to the solid will not be increased materially either as the result of further oxidation of the inter-conal gases or shift in the water-gas equilibrium.

Results are quoted of experiments made to test the effect of variation in the surface of the gas fire radiant on the radiant efficiency. A coating of uranium oxide increased, and of alumina decreased, the efficiency recorded.

The importance is demonstrated of ensuring good combustion of the inter-conal gases. At low consumptions the supply of air is relatively greater per c.ft. of gas burned, with the result that, in the case of the highly aerated flame, there may be an excess of air, diluting unduly the burning mixture and causing a chilling of the radiant. The major part of the energy emitted by a fire comes from the incandescent portion, but little conversion to radiant energy by the heated products being possible once they have passed away from the radiant. By attention to the details which affect the working of the appliance an approach can be made to the ideal of attaining a uniformly high efficiency over a wide range of consumption with good combustion.

The report concludes by recording the results of determinations of the relative proportions of energy radiated by the fire which come directly from the heated gases and from the solid radiators. Gaseous radiation accounts for not more than 10% p.ct. of the total heat radiated, this radiation being only about one-third of that which would have been emitted by the freely burning flame.

The investigation viewed as a whole indicates:

(1) That while the energy radiated by a freely burning flame varies with the aeration, it emanates principally from the heated products of combustion.

(2) That when the amount of radiation is increased by inserting solids within the flame or by allowing the flame to burn within a solid mantle, the amount of the increase and the quality of the energy are determined largely by the surface properties of the solid used. The extent of the "surface effect" is much modified, however, by the shape of the radiator.

The use of a solid emittor in conjunction with the flame lessens the amount of energy radiated directly by the heated products of the flame combustion.

(3) That when the gas is burned within a radiant the flow of secondary-air and the completion of the combustion of the inter-conal gases of the Bunsen flame influence appreciably the radiant efficiency attained.

Ideas in Plenty.

The discussion on the paper, opened by Prof. Bone, was one of the most highly technical to which the Institution can have listened. It was, in fact, like being at a meeting of the Royal Society or the Faraday Society. At the same time, however, the practical essence of the question of gaseous heating was uppermost. There was general agreement with Prof. Bone, who paid a glowing tribute to the knowledge, enthusiasm, and skill of Dr. Hartley, that both the Industry and Radiation, Ltd., are to be congratulated on the presentation of the paper. Prof. Bone said that any luminosity in a gas, however produced, implies considerable electronic displacements, even to the complete expulsion of electrons, and that the former view long maintained by Paschen that the radiation from flames is purely thermal in origin must now be abandoned in favour of a chemical origin. Dr. E. W. Smith, who followed, remarked that the placing before everyone of the fundamental theories of gaseous heating is a gesture on the part of Dr. Hartley and his Company which is of very great importance, and "almost epoch marking in the annals of the Industry." Dr. Smith hopes that gas fire development will be on evolutionary lines without sudden changes; and he hopes also that collaboration between the makers of gas appliances and the Gas Industry will be extended.

Dr. Margaret Fishenden was in critical mood. She thinks it is insufficiently realized that a surface need not be very hot to give a big proportion of radiation, and that the design and size of the gas fire is wrong geometrically. "Gas fires are specifically recommended for intermittent use—*i.e.*, you go into a room where the walls are relatively cold and the surfaces are relatively cold, and you turn on about half a square foot at a very high temperature. Quite apart from any wavelength considerations, I think that is

wrong geometrically. The wretched human being in his endeavours to counteract 99% of the total subtended angle at a very low temperature has to scorch himself locally. Perhaps some system of a conducting front flue surface would help."

The remarks of Mr. W. E. Benton, of Cannon Iron Foundries, Ltd., and Dr. Burrows Moore, of Thermal Syndicate, Ltd., may be looked upon as complementary. The idea is to use a diffusing envelope of translucent Vitreosil, the selectivity of which reduces the undesirable region of the infra-red radiation in favour of the desirable. By passing the radiant heat through a screen of Vitreosil, the "scorching" part is completely absorbed. Cannon Iron Foundries hope shortly to bring out "a portable gas fire having a reasonably good radiant efficiency, and producing perfectly harmless products of combustion. The heat radiated from this novel gas fire will be almost entirely of short wave-length energy. The radiant efficiency will be lower than that of an inclined gas fire, but with the high degree of combustion the whole of the remainder of the net calorific value will be available for convective heating."

Useful suggestions were put forward by Mr. C. A. Masterman, who said: "A closer structure radiant combined with reduced heat losses from the back of the radiant is found to result in a considerable increase in the emission of forward radiant heat without prejudice to a cheerful appearance or good combustion. There is no doubt that the knowledge possessed by the gas fire manufacturers of the effect of such heat conservation will lead in the not distant future to the production of fires having a considerably increased thermal efficiency. It is possible to anticipate with confidence 7-radiant fires having an unchanged gas rate but giving an amount of radiant heat to the room corresponding to that now obtained from a 9-radiant fire." The observations of Mr. H. J. Hodsman on the radiation from lighting burners are also full of interest. On the question of incandescent burners, Mr. L. H. Sensicle suggested the use in a gas fire of either upright or inverted mantles combined with an amber-tinted silica screen to reduce the glare. The radiation from such a fire would be most comfortable.

The Sigma B.Th.U. Recorder.

During the year, Mr. Wood has undertaken a detailed and critical analysis of the Sigma B.Th.U. recorder, to ascertain what could be expected from it if put into use as an official recording instrument under the Gas Regulation Act of 1920. It had been notified by the Gas Referees that, as an alternative to the more elaborate forms of recording calorimeter, the Gas Referees might prescribe for specified testing places the provision of a Sigma B.Th.U. recorder, used in conjunction with a Boys non-recording calorimeter for testing places for gas undertakers who sold in the previous year not more than 100 million c.ft. of gas.

The Sigma instrument is simple and robust in construction, compact, and relatively cheap. It requires no water supply and no drain, so that installation difficulties are much reduced. As a result of Mr. Wood's investigation we now know what may and what may not be expected from the instrument. It would appear that the recorder is one which may be very useful in small or medium size undertakings as an aid to securing greater uniformity of calorific value, but may not prove sufficiently accurate for its readings to serve as the basis of penal action. It may, in general, be expected to indicate the gross calorific value of town gas with an error of not more than ± 2%, and more nearly where daily checking is practicable. The way in which these conclusions have been derived is indicated in the report presented by Mr. Wood, which contains a detailed account of the investigation, and in Appendices which are included.

Fuel Research Board Tests.

In 1926 and 1927 the Fuel Research Station tested a Sigma instrument; and Mr. A. Blackie, the first speaker in the discussion, summarized this hitherto unpublished experience. In general, he said that the Sigma is usually reliable to within 10 B.Th.U., or, say, 2%, but in abnormal circumstances the error may be 20 B.Th.U. "I think all will agree," remarked Mr. Blackie, "that Dr. Stewart in his design has succeeded in combining simplicity and robustness with a degree of accuracy which meets practical requirements in a very successful manner." Mr. C. B. Howarth, of Newcastle, who has had experience of Sigma recorders for works control, confirms the Committee's view that with reasonable care the instrument is likely to have a long life.

The meeting was highly interested in the speech of Mr. Butterfield, one of the Gas Referees, who has knowledge of the behaviour of the instrument in other conditions through the records which have come to the Gas Referees' Office from a large number of places. "As regards inferential instruments generally," he remarked, "this instrument, a few years ago, was found by myself and my colleagues to be the best of the inferential recorders, and so far as I know it remains as good as any other to-day. Another inferential instrument is now approved by the Gas Referees as an alternative to the Sigma. That is the R type of Simmance calograph; and we are satisfied that its behaviour is substantially as good." Perhaps the chief point made by Mr. Butterfield is that each Sigma instrument must be judged independently. There are differences between individual instruments which cannot at present be accounted for.

Dr. Stewart observed that there is no mention in the report of the accuracy of the standard calorimeters used. "It is known that they may have uncorrected errors due to radiation, and resistance to the rotation of the meter. While these were probably negligible a statement of their limits would have improved the report, particularly as it is too generally believed that it is impossible to err in using a standard calorimeter. The report considers it a disadvantage that the Sigma recorder must be set by comparison with an independent standard water flow calorimeter. I think this opinion wrong. Standard instruments converted into recorders have been known to lose their accuracy in the conversion, and to suffer by continual use." Dr. Stewart mentioned that the Sigma instrument is the subject of continual observation and experiment with a view to modification and improvement.

Intermittent Vertical Chambers.

The remaining report of the Joint Research Committee and Leeds University, presented at the final session of the meeting on Wednesday afternoon, deals with a test of the Woodall-Duckham intermittent vertical chambers at Croydon. The details of the construction of the setting were described by Mr. Grogono, Engineer to the Croydon Gas Company, in the "JOURNAL" for Dec. 2 last, and a description of a similar plant was included in Mr. Thomas's Institution paper on the installation at the Southall Works of the Gas Light and Coke Company. In both these papers the extraordinary flexibility of the plant in make and quality of gas was stressed, and also the latitude in coal buying. However, the results previously published are insufficiently comprehensive for the preparation of chemical and heat balances; and the aim of the report was to render the available data more complete by the construction of such balances for this type of carbonizing plant recently introduced into this country.

Throughout the test the plant more than maintained its rated capacity of 3½ million c.ft. of gas per day. The daily make averaged 3,616,000 c.ft. over the month, a figure which corresponds with a volume of gas of 14,320 c.ft. per ton of coal carbonized. The calorific value of the gas was 549 B.Th.U. per c.ft., and hence the thermal yield of gas amounted to the satisfactory figure of 78·62 therms per ton of coal carbonized.

Both the carbon dioxide and the nitrogen contents of the gas were low. The actual percentage of nitrogen present in the purified gas was 5·81. Of this amount 2·59% came from the air admitted for purification, leaving 3·22% as the nitrogen content of the gas in the retort house. The nitrogen balance of the coal supplied to the chambers shows that 1·17% of the nitrogen in the gas came from the coal, and accordingly, 2·05% of the total gas made represents nitrogen drawn into the chambers as air or waste gas.

The weight of coke made was 13·90 cwt. per ton of coal carbonized. After deducting the coke supplied to the producers as fuel, 11·29 cwt. remained for sale. The average volatile matter in the coke was 1·3%.

Apart from the small amounts of electrical energy used, the sole source of heat for the whole process of carbonization was the potential heat of the coal supplied, since the plant met its own fuel and steam requirements. The Efficiency of Gas Production equals 63·2% when expressed as the heat in the gas, divided by the sum of the heat in the gas *plus* the heat used and lost in manufacture. The Efficiency of Carbonization equals 85·3%, and is given by the sum of the potential heats in the products gas, tar, and coke for sale, divided by the total heat supplied as coal.

Help for All.

The discussion provoked both congratulation and constructive criticism. It is plain from the remarks of Mr. F. B. Richards and Mr. A. H. Lymn that the report will be of direct use to the actual constructors and designers of plant; while Mr. Carmichael, Mr. Grogono, and Dr. Pexton made it clear from the point of view of the practising gas engineer and chemist, anxious to obtain the very best results from the plant, that here again the report has its sphere of usefulness. The report, said Mr. Carmichael, is

further evidence of the value of intermittent vertical chambers as a process of carbonization in the Gas Industry; and he expressed his complete agreement with the adoption of 28 days as the test period. He remarked that the use of graded coke instead of breeze for the pad is distinctly uneconomical, and asked why this method is practised. He suggested that it might be a desire to reduce internal bottom pressure in the retorts; but " the disuse of the bottom offtakes altogether has, on occasion, seemed to have little effect on results, and it would be interesting to know exactly to what extent results given in the report have benefited by the use of a bottom offtake and main. Mr. Carmichael also queried the economic soundness of installing a waste-heat boiler to work under the conditions of the plant at Croydon. From the waste gases 5·5 therms is recovered, while 9½ therms is lost in sensible heat in the coke.

Mr. Thorman, who discussed the influence of combustion flue temperatures, is disappointed at the lack of reference to benzole yield in the report. In view of the lucrative market for benzole, information as to its yield, and particularly its quality, would be of value. The nitrogen content of the gas made during the test is extraordinarily low, which says much for the quality, design, and maintenance of the chambers—that after three years' service such excellent working is being maintained.

Mr. Lymn remarked that the report confirms, almost in entirety, all the results given by Mr. N. J. Bowater in a paper before the Institute of Fuel in November, 1927. Mr. Lymn also suggested that the Research Committee might investigate outside gas producers of the most modern mechanical type supplying cool clean gas to the vertical chambers, and also outside hot gas step-grate producers—in which respect he would be glad to offer any assistance.

Refractory Materials.

The technical business of the meeting came to an end with the discussion on the Report on Refractory Materials, presented by Mr. A. T. Green. Among the matters dealt with during the year is the hot-patching of gas retorts. In regard to the application of cement in the wet form, laboratory investigation has been made of the effect of the addition to the wet cement of small amounts of organic matter and also of varying water percentages on the " stickability " of the added layer in particular, as well as of the comparative results obtained by the methods of addition in common use—namely, by placing the cement in position with the paddle, by spraying, and by means of the shot-gun. In addition, admixture of inorganic materials with the cement has been tried. While some improvement was obtained in a number of instances, the experiments do not permit the recommendation of any cement mixture as being generally capable of fully successful application in paste form to a hot retort surface.

Experiments were then carried out to ascertain the effect of the application of the cement in a dry finely divided state by means of (*a*) compressed air, and (*b*) by means of a blowpipe flame. By the latter method encouraging results have been obtained, especially in respect to the " stickability " of the added cement layer.

Further results were obtained on the permeability of refractory materials. The permeability of the different samples has been determined at 850° C., and has confirmed the finding indicated by previous figures obtained up to 500° C., that the permeability decreases with increasing temperature. It appears that leakage from gas retorts at high temperatures (as distinct from leakage through joints and cracks) is in all cases very slight, although in general it is rather greater from silica than from fireclay retorts.

In regard to the disintegration of refractory material by the action of carbon monoxide. Previous work had shown that certain types of " iron spots " were the centres around which disintegration occurs, and it was indicated, although not proved, that the iron spots of a dangerous character were those containing free " iron oxides " and that those in which the iron was present in combination, as in silicate, were relatively innocuous. The further work has confirmed this, and it has also been shown that increasing the temperature and time of firing the material increases its resistance to disintegration.

A Successful Appeal.

Introducing the report, the Chairman, Dr. Colman, expressed the gratitude of the Sub-Committee and of the Council of the Research Association for the generous response to a special appeal for increased support. This appeal was issued to manufacturers and users, and as a result increased and additional subscriptions have been promised. To this successful outcome, which ensures a grant from the Department of Scientific and Industrial Research, the Gas Industry has been a large contributor, the total promises by the Institution from its Research Fund and from individual gas undertakings having been increased from about £530 to £2240.

The discussion was opened by Mr. F. West, who observed that the work on permeability, while indicating that the amount of gas leakage through retort material at working temperatures is comparatively small, is also leading to a possible means of controlling the liability of retort materials to " flaking " and " erosion " during their working life. Another point of interest revealed by permeability investigations is the fact that diatomite material has a remarkably high resistance to gas penetration as well as to heat penetration. In a similar manner the study of the disintegration effect of carbon monoxide on certain types of refractories, while indicating to manufacturers weaknesses in their products, also illustrates to the gas engineer the mechanism of one contributory factor to the " flaking " of retorts.

Mr. West suggested two further problems which might be investigated with advantage to the Gas Industry. The first is the swelling of various coals in relation to grading size, and, when plastic, their penetrative effects on the refractory material. Then, secondly, some attempt at the definition of the expansion stresses in retort structures, especially with reference to shape of the structure, should be made in order to appreciate more fully the liability of the retort to cracking and spalling at certain positions. This would also necessitate the exploration of the temperature conditions existing on the inside face of the retort under varying conditions, especially in relation to the formation of carbon or scurf in the retorts and the extent of heat changes during the burning off of the carbon. " I believe this is a very important point," said Mr. West, " and may be largely responsible for much of the spalling which takes place on silica refractories."

Mr. A. A. N. Carpenter told the meeting of how he had found both a satisfactory cement for hot patching, and also a successful method of applying it to vertical retorts; but he left us in the dark both as to the composition of the cement and the method he has adopted. Mr. T. Allen, as a manufacturer, paid testimony to the practical value of the work directed by Mr. Green, which has effected improvements in manufacture which otherwise would have been improbable. Bouquets to Mr. Green were also thrown by Mr. T. F. E. Rhead, who obviously has no faith in wet patching.

Closing Stages.

The President, having reported that the next annual general meeting of the Institution will be held in Liverpool on May 30 and 31 and June 1 and 2, 1933, explained the arrangements which have been made for the Institution, accompanied by other members of the British Gas Industry, to visit Canada and the United States of America in September and October next year, and to participate in the Conventions of the Canadian Gas Association and the American Gas Association and the Chicago Centennial International Exposition. Mr. Gibson's remarks in this connection are published on later pages.

Dates to Book.

Mr. Gibson reported that the next research meeting of the Institution had been fixed for Nov. 7 and 8, 1933. The meeting place will be London. The Second International Gas Conference will take place in Zurich in September, 1934.

An Omnibus Vote.

The meeting was concluded by a vote of thanks, proposed by Mr. H. E. Bloor. In the first place he thanked the University of Leeds, the Livesey Professor, the research chemists, assistants, and staff, and the authors of reports. " All these," said Mr. Bloor, " represent that close association between our Industry and the scientific side which we chemists, assistants, and staff, and the authors of reports. heart and soul to bring the service of science to our Industry. and they on their part are co-operating and serving the Industry in an admirable manner.

" Then we have to give our thanks to the undertakings and gentlemen conducting research work for the Institution or providing facilities therefor. This section, I suggest, shows what every gas engineer learns in his early youth—namely, the extreme willingness of every member of the Industry and every undertaking in the Industry to help others in the Industry.

" Next we tender our sincere thanks to the Chairmen and Members of the Gas Education Committee. the General Research Committee and its Sub-Committees. the Technical Committees, and the Joint Research Committee of the Institution and Leeds University. To our hosts, the Institution of Mechanical Engineers we also return our thanks for their great kindness in allowing us to use their building. Then I come to the Secretary and staff of the Institution. I feel it is quite impossible for anybody to give any thought to the immense development in the Institution, in both its

members and its work, without realizing that in Mr. Alexander we really have a winner. His staff are working together enthusiastically and loyally and with extraordinary efficiency in our service.

"Finally, I have to ask you to give your hearty thanks to the President. All these forces which have been indicated in this vote of thanks have to be co-ordinated in some way. Their work is co-ordinated by the Council and primarily, at the head of the Council, by the President. Everybody is looking forward to the President's year of office with the keenest interest, and we hope and believe it will be a memorable year."

The President, replying, endorsed Mr. Bloor's remarks about the work of Mr. Alexander and his staff, and expressed his appreciation of the help of every member of the Council and the Hon. Secretary.

The Institution's Visit to Canada and the United States

At the Autumn Research Meeting of the Institution of Gas Engineers, the PRESIDENT (Mr. Ralph E. Gibson) made the following announcement:

In the 69th Annual Report of the Institution of Gas Engineers, presented at the Annual General Meeting in June last, it was stated that the Council of the Institution had accepted the cordial invitations which had been received from the Canadian Gas Association and the American Gas Association, to visit Canada and the United States of America from Sept. 8 to Oct. 16, 1933, and participate in, *inter alia*, the 26th Canadian Gas Convention, the 15th American Gas Convention, and the Chicago Centennial International Exposition.

It is particularly appropriate that the visit has been arranged to take place in 1933. That is the 70th year of the Institution, and our fellow countryman, Mr. Arthur Hewitt, of Toronto, has the honour to be the President of the American Gas Association for 1932-33.

COST.

In the Official Programme of this 4th Autumn Research Meeting, the names of the cities to be visited are tentatively given, together with the specially arranged, wholly inclusive cost of the tour, which it is estimated will not exceed the relatively moderate amount of £130 per member, excluding wines but including all gratuities, except those incurred at sea. Further elaboration of the tour, or adverse alteration in the rate of exchange, would normally increase the cost, but this possibility has been disregarded in estimating, since such increase would in fact be offset by the generous hospitality which we are to receive from our overseas colleagues.

ORGANIZATION.

The entire arrangements are being made by the Institution of Gas Engineers in conjunction with a Reception and Arrangements Committee appointed by the Canadian Gas Association and the American Gas Association, under the Chairmanship of Mr. Clifford E. Paige, of Brooklyn, N.Y., who will be remembered by us all. Participation in the visit is not restricted to members of the Institution, but is cordially extended by the Council to all bona-fide members of the Gas Industry in the British Isles, and to members of the Continental and Overseas Gas Associations. Ladies are particularly invited to participate, and special arrangements will be made in Canada and the United States for their entertainment.

OBJECTS OF THE VISIT.

The visit is being planned in order that we may see all that we possibly can in the time at our disposal, of the manufacture, distribution, and utilization of gas in the great Canadian and American cities to be visited. In addition, however, to visiting some natural gas centres and the gas-works, showrooms, and districts of certain gas undertakings, the chief trades and industries will be inspected, and opportunities will be afforded members of coming into close personal contact with our kinsmen overseas and of seeing the outstanding architectural and physical features and the life of the two countries.

The Canadian Gas Association has kindly postponed its next Annual Convention from June to Sept. 18 and 19, 1933, in order that we can participate in that event when we reach Ottawa. Further, the American Gas Association has specially fixed the date of its Annual Convention for Sept. 25-28, 1933, so that we can attend that gathering when we reach Chicago, and visit the Chicago Centennial International Exposition. At this great Exposition, which has been planned on a scale similar to the British Empire Exhibiton at Wembley some years ago, an "Old Europe" Section is being built.

ITINERARY.

The present arrangements are that we shall sail from Liverpool on Sept. 8, 1933, on the 20,000 ton S.S. "Duchess of Bedford." On reaching Quebec on Sept. 15, a few hours will be spent in the city and we shall then continue by the ship to Montreal. After a day at Montreal we shall go by train to Ottawa, where two days will be spent. We shall then travel to Toronto and, after a day there, we shall visit Hamilton, Niagara Falls, and Detroit on successive days, and then journey to Chicago, where we shall remain for four days.

We shall next inspect the Laboratories of the American Gas Association in Cleveland and then proceed—via Pittsburgh, Washington, and Philadelphia (staying for a day in each of these cities)—to New York City, to which three days will be spent in the city and we shall then continue by the Boston, whence we depart on Oct. 8, on the M.V. "Georgic," a ship which sailed on her first voyage in June of this year. We hope to reach Liverpool on Oct. 16, the whole tour having taken 39 days.

ADVANTAGES OF PARTICIPATION.

A marked impression has been made upon the minds of the members of the Gas Industry in this country as to the extraordinary achievements, developments, and potentialities of the American and Canadian Gas Industries. I feel confident, therefore, that those participating in the tour will usefully implement their knowledge and be afforded much pleasurable experience and education. We shall have the privilege of meeting our kinsmen overseas and of discussing problems of mutual interest, all of which will enable us to further the interests of the great public utility which it is our privilege and pleasure to serve.

I urge all my professsional brethren, and not least the younger members, to do their utmost to join the tour and take the opportunity of visiting these two great countries in circumstances and under conditions which may never again be afforded. The visit should prove of inestimable practical value to those participating in it and will, I believe, contribute something towards the advancement of the cause of mutual understanding and co-operation between English speaking people.

ACKNOWLEDGMENT OF CANADIAN AND AMERICAN CO-OPERATION.

I take this opportunity of expressing our cordial appreciation of the enthusiasm with which our Canadian and American colleagues are co-operating with us in making the arrangements for the visit. In particular I should like to acknowledge our indebtedness to Mr. Arthur Hewitt, Mr. R. W. Gallagher, of Cleveland, Ohio, Immediate Past-President of the American Gas Association, Mr. Hugh McNair, of Winnipeg, President of the Canadian Gas Association for 1932-33, and Mr. Clifford E. Paige, of Brooklyn, N.Y. Major Alexander Forward, Managing Director of the American Gas Association, and Mr. George W. Allen, Secretary-Treasurer of the Canadian Gas Association, have co-operated to the utmost with our Secretary, Mr. J. R. W. Alexander, in initiating and making the preliminary arrangements for the visit; and I feel sure that the continuance of their cordial collaboration will ensure its entire success.

REGISTRATION.

All those interested in the visit should take the earliest opportunity of communicating with the Secretary, who will be pleased to provide any further information and afford any assistance required. A registration fee of one guinea per member is payable, which will be refunded if participation is cancelled before a date to be notified.

Priority will be accorded, where necessary, to those participants first making definite registration. Although the tour is ten months distant, it will be appreciated that the arrangements—particularly as to Government and other Official receptions—have to be completed forthwith and are to some extent dependent upon the numbers taking part. I venture, therefore, to invite immediate consideration of the matter and the earliest possible intimation of interest or participation.

Autumn Research Meeting Luncheon

Many Distinguished Visitors.

The Fourth Autumn Research Meeting luncheon took place at the Royal Automobile Club on Tuesday, Nov. 1—Mr. R. S. GIBSON, President of the Institution, in the chair. Among those accepting invitations were Mr. A. Abbott, C.B.E., M.A., Chief Inspector, Technological Branch, Board of Education; Prof. C. V. Boys, F.R.S., Gas Referee; Mr. W. J. A. Butterfield, M.A., Gas Referee; Mr. W. A. S. Calder, Immediate Past-President, Institution of Chemical Engineers; Dr. H. T. Calvert, M.B.E., Director, Water Pollution Research Division, Department of Scientific and Industrial Research; Mr. William Cash, J.P., President, British Commercial Gas Association; Dr. G. C. Clayton, C.B.E., J.P., M.P., Chairman, Liverpool Gas Company; the Right Hon. J. R. Clynes, J.P., D.C.L.; Mr. W. A. Damon, B.Sc., Chief Alkali Inspector, Ministry of Health; Mr. R. W. Edwards, Chairman, Gas Companies' Protection Association; Dr. Margaret Fishenden, City and Guilds (Engineering) College, Imperial College of Science and Technology; Mr. A. A. Garrett, M.A., B.Sc., Secretary, Society of Incorporated Accountants and Auditors; Mr. P. Good, Deputy Director, British Standards Institution; Sir Francis Goodenough, C.B.E., Chairman of the British Commercial Gas Association; Mr. F. A. Greene, Honorary Treasurer, Institution of Chemical Engineers; Mr. A. L. Griffith, Secretary, Society of British Gas Industries; Prof. J. S. Haldane, C.H., F.R.S., Gas Referee; Mr. William Henderson, Secretary, British Sulphate of Ammonia Federation; Mr. C. H. Isdell-Carpenter, O.B.E., Secretary, Chartered Institute of Secretaries; Sir Murdoch MacDonald, K.C.M.G., C.B., M.P., President, Institution of Civil Engineers; Dr. J. W. Mellor, F.R.S., Director of Research, British Refractories Research Association; Sir David Milne-Watson, LL.D., D.L., President, National Gas Council; Dr. A. Morley, H.M.I., Staff Inspector, Board of Education; Brig.-General Magnus Mowat, C.B.E., Secretary, Institution of Mechanical Engineers; Mr. Philip B. Nicholson, Honorary Treasurer, Coke Oven Managers' Association; Mr. F. R. O'Shaughnessy, Chief Chemist, Tame and Rea Drainage Board (Birmingham); Dr. A. Parker, Assistant Director, Water Pollution Research Division, Department of Scientific and Industrial Research; Mr. C. W. Peck, C.B., Scottish Education Department; Sir Joseph E. Petavel, K.B.E., D.Sc., F.R.S., Director, National Physical Laboratory (Teddington); Sir Robert Robertson, K.B.E., M.A., D.Sc., F.R.S., Government Chemist; Mr. P. F. Rowell, Secretary, Institution of Electrical Engineers; Sir E. John Russell, O.B.E., D.Sc., F.R.S., Director, Rothamsted Experimental Station; Dr. F. S. Sinnatt, M.B.E., Director, Fuel Research Division, Department of Scientific and Industrial Research (London); Sir Alexander Walker, K.B.E., Director, John Walker & Sons, Ltd.; Mr. J. C. Walker, General Secretary, British Commercial Gas Association.

WORK OF THE UTMOST VALUE.

The CHAIRMAN, proposing the toast of "Our Guests," extended to them, in the name of the Institution of Gas Engineers, a very cordial welcome. The main object of this luncheon was to show their appreciation of the work carried out on behalf of the Gas Industry by the various Research Workers and Technical Committees of the Institution, who had been actively engaged in scientific and technical investigations during the past year, and by those who had served the Institution and the Gas Industry so well during the year in connection with the Education Scheme. They were also much indebted to the undertakings who had given facilities for research on their works, and to the members and the staffs of those works for the co-operation they so willingly extended to the research workers at all times. Without the assistance of those undertakings much of the work would have been impossible. The reports that were being presented at this Autumn Meeting were direct evidence that a vast amount of work had been accomplished—work of a useful character, which he believed would be very helpful in many directions in the future. The reports touched many phases of the Gas Industry, including construction, manufacture, distribution, and utilization. It was not necessary before a gathering such as this to emphasize the importance of research. They all knew as well as he did that the great industries of this country, if they were to advance, could not afford to neglect research. The Gas Industry had fully realized this need, and through the Institution of Gas Engineers, and mainly in conjunction with Leeds University, had carried out much valuable research work over many years. There was a tendency, however, on the part of some to become uneasy and impatient, because certain lines of research did not show immediate results from a commercial point of view. He was afraid, from the very nature of research, practical results could not always be expected immediately. It was sometimes a case of casting bread upon the waters, which would be found after many days. But he ventured to say that the work done by the Institution of Gas Engineers in conjunction with Leeds University in past years had been of the utmost value to the Gas Industry. ["Hear, hear."] He did not mean to infer that there had always been practical and tangible results from this work. This was hardly to be expected. There appeared to be at the present time an insistent demand for research or technical investigation which would have an immediate bearing upon present-day problems, and this particular aspect of technical development was receiving the attention of the Council of the Institution.

THE LATE SIR ARTHUR DUCKHAM.

At this luncheon a year ago they were favoured with the presence of Sir Arthur Duckham. The Gas Industry had suffered a severe and irreparable loss in his passing away. Sir Arthur was always an ardent supporter of the Institution of Gas Engineers and was specially interested in its research work. It was a source of satisfaction to them that the Sir Arthur Duckham Memorial Fund had been launched, and that the Committee appointed to deal with the matter had decided that the Fund should be applied to the Research Work of the Institution in some way or other—an object which, it was thought, would have met with the approval of Sir Arthur himself.

THE BEST METHODS OF UTILIZING COAL.

Before closing his remarks, the President said he would like to make reference to their great parent industry—the coal industry. They must all view with concern the critical stage through which it had been and was still passing. He believed that the present position of the coal industry was, to some extent, due to the fact that, while a large amount of research work on behalf of the coal and fuel industries had been done, the coal industry had somewhat neglected to apply to its business the results of that research. In his view the salvation of the coal industry lay in the direction of utilizing coal by the methods employed by the Gas Industry—that was, by carbonization. If the newly-formed Coal Utilization Council would devote its energies to the furtherance of this method of utilizing coal, rather than to increasing the sale of raw coal for domestic purposes, it would make some progress towards a better state of things. ["Hear, hear."] It should realize that, if more gas and smokeless fuel were used, more coal would be required for the manufacture of these fuels; and ultimately this would more than compensate for any loss in the sale of raw coal for domestic purposes. He fully believed that the age of smokeless fuel, gaseous and solid, along with the manufacture of home-produced oils from coal, was coming, whether the coal industry liked it or not. It was only a question of time. While the Gas Industry wished to be an ally of the coal industry, it could not look with equanimity upon the attitude displayed by the coal trade in putting up the price of coal to public utility undertakings. Such action was not in the best interests of the coal industry.

The guests that day included, not only the members of their Research Staffs and Technical Committees, but many distinguished men connected with the Gas Industry by various ties, who had honoured them with their presence. As lists of the guests had been prepared, it was needless for him to mention names, but he would like to make one exception—Dr. G. C. Clayton, C.B.E., M.P., the Chairman of the Liverpool Gas Company. Dr. Clayton's presence he personally very much appreciated. The toast was coupled with the name of Sir John Russell, but before Sir John replied he would like to ask Mr. A. Abbott, Chief Inspector of the Technological Branch of the Board of Education, to read a message from Lord Irwin, President of the Board of Education and Ex-Viceroy of India, who regretted that he was unable to be with them. By the way, he understood that Mr. Abbott was shortly retiring from the position he now held. Mr. Abbott had been closely associated with their Education Scheme since its inception, and they were much indebted to him for all the assistance he had rendered in connection with that scheme.

Message from Lord Irwin.

Lord IRWIN's message, in the following terms, was then read by Mr. Abbott:

I am extremely sorry that the calls which meetings of the Cabinet and its Committees are at present making upon

Ministers' time have prevented me being with you at your Autumn Research and Education Meeting Luncheon. I know, however, that although I cannot express to you in person—as I should have wished—how highly I regard the educational work of the Institution, I can rely on Mr. Abbott to do so for me.

In the competitive conditions of to-day, among the first concerns of any great industry must be the training of its recruits and the raising of the level of knowledge and application of those responsible for its control and expansion. Nothing has, therefore, afforded me keener satisfaction on my return to the Board of Education than the account which I have heard of the progress in these directions which your Institution and other great professional institutions like it have made—a progress to which the number of schemes of co-operation with the Board of Education on a national basis now in existence bears witness. That you should have been able to establish such a widespread and effective organization on so firm a basis within the short space of ten years, is a testimony alike to the determination of the Gas Industry to hold its own with its competitors and to the wisdom and vision of those who direct it.

Part-Time Day Teaching.

Since one of the essential purposes of an annual gathering of this kind is to take stock of past achievement and prepare the ground for future advance, you will not take it amiss if I ask you to focus your attention on one facet of our educational structure in this country in which, I fear, there is some reason to think we are lagging behind our competitors abroad. I refer to the disappointingly small provision which our Industry and Commerce at present make for part-time attendance at vocational classes organized during the day time.

I understand that most of the instruction now being given to students of gas manufacture and distribution is provided in classes held in the evening when the students have finished their day's work, but the benefits to be obtained from such evening instruction, when the students must inevitably be physically and mentally tired, cannot, in my opinion, bear any comparison with those obtainable at day classes. The fact that only some 15,000 to 16,000 of the students from all the various occupations in Industry and Commerce in this country are now released to attend such classes as compared with some 170,000 in, for example, Czechoslovakia, is at once a measure of the leeway which we have to make up and a challenge to the progressive industries like the Gas Industry to give a lead to others by making part-time day instruction the rule rather than the exception.

I know very well how great are the difficulties of industry to-day—and many of them it is not in our power alone to remove. But the very difficulties under which we labour are powerful arguments for seeing that we make the utmost use of all the resources at our disposal, and I greatly hope that it may be in the power of your Institution to set an example to other leading branches of our Industry and Commerce in discovering, and taking increasing advantage of, the facilities which our existing Educational System has to offer them. In any efforts you may be able make in this direction, I need not assure you that you will carry the interest and goodwill of all educationists, whom I at present have the honour officially to represent.

Bye-Products and Agriculture.

Sir John Russell, O.B.E., D.Sc., F.R.S. (Director, Rothamsted Experimental Station), responding to the toast of "Our Guests," said that, whatever the future might have in store, there was no question that at the moment coal represented our cheapest form of energy, and in using the gas process one not only obtained the maximum efficiency of coal, but at the same time recovered the bye-products. As an agriculturist, it was in the bye-products that he was interested. The 1 ton of coal which would keep a fair-sized house comfortably warm for a month also contained enough nitrogen to supply, if used agriculturally, a man and his wife with food for a month. They did not use this nitrogen adequately. Then there were the phenols and things of that sort. In our orchards, &c., there were lost annually vast sums through the depredations of insects and fungi, and many of these could be kept in check by the proper use of phenols and like substances. This great Gas Industry, with its many ramifications, had as its co-ordinating body the Institution of Gas Engineers, with its wide range of activities. It had accomplished a very great deal. It must, however, be served by really good officers, which it undoubtedly possessed. The great work which the President had done at Liverpool was known far beyond his own borders.

An Equitable Balance.

Sir Murdoch MacDonald, K.C.M.G., C.B., M.P., who submitted the toast of "The Institution of Gas Engineers," said it was a great pleasure to him that his very first official act as President of the Institution of Civil Engineers should be to propose the toast of such a kindred institution as the Institution of Gas Engineers. There was every reason why this toast should be proposed by a member of his own Institution. He understood that the great Charles Hawkesley, a former leader in the gas profession, was also in his time President of the Institution of Civil Engineers. He, himself, was happy indeed to think that the originator of the Gas Industry, William Murdoch, should have had to some extent the same name as himself. Parliament, of which he was a humble member, had duties to perform in connection with their Industry. It had to keep an even balance of justice between gas and its competitors, but he sometimes heard that this balance was not so equitably kept as it might be. ["Hear, hear."] If this was so, then, so far as he was concerned, he would do what little he could to see that the balance was equitably maintained in regard to gas, as well as other industries. He fully realized that this country's future depended for hundreds of years to come on the proper use of coal, and that everything which would encourage this proper use of coal was bound to be of immense advantage to them. At Liverpool their President produced a smokeless fuel, the use of which was intended to clarify the atmosphere of their big towns. Fuels of this kind must be of inestimable benefit, and he hoped it was one of the things on which the Institution would focus their research. Any fuel which would not have the deleterious effects on the atmosphere which were caused by the use of raw coal would have his blessing, and if the Gas Industry came to Parliament and asked for compulsory powers to use such a fuel he would be delighted to help them.

Mr. J. Herbert Canning, O.B.E., Immediate Past-President, who replied, said he would be expressing the wish of everyone present in hoping that Sir Murdoch MacDonald would have a most successful year of office as President of the Institution of Civil Engineers. Sir Murdoch bore a name honoured in the Gas Industry—the name of Murdoch, who 140 years ago laid down those principles upon which gas supply and practice had been founded ever since. If they continued in the lines he had laid down, they would continue to extend and to prosper. He was certain that Murdoch also did a great deal of research work, in spite of the primitive appliances which were all he had at the time. Ten years after he first invented gas lighting, he illuminated the works of Boulton & Watt, at Birmingham, during the celebration of the Peace of Amiens, and this must have necessitated much research. Their Institution had followed on these lines, and had continuously conducted research. The Chairman had told them that research did not always at once bring about practical results, or results in £ *s. d.*, but he (Mr. Canning) might say, without fear of contradiction, that research in the Gas Industry had always resulted in progress and prosperity in the long run.

The Coal Industry's Best Weapon.

Reference had also been made by the Chairman to the connection between the Gas Industry and the coal industry. This was a point which required to be particularly stressed at the present time, when the coal industry was to a large extent fighting for its life against the competition of oil. The ever-increasing use of gas would furnish the coal industry with one of the most valuable weapons it could employ in its fight against foreign oil. There appeared to be two schools of opinion in the coal industry. The coal industry generally had lately adopted for its slogan "Back to Coal." He felt that this was a retrograde slogan. It was looking back on conditions that had passed away, and which would not recur. It made one feel that at any rate there were some people in the coal industry who were looking forward to the greater use of raw coal, with its resultant soot and ashes. This was a thing that most people did not want to look forward to. On the other hand, there was another school which was looking too far forward—that was, to the day when, either by low-temperature carbonization or hydrogenation, the coal industry would be able to supply large quantities of home-produced oil. Between the two schools, backward and forward, the coal industry might find itself in a perilous position, unless it used the weapon which was ready and closest to its hand—namely, gas.

Before closing, he would like to refer particularly to the message which had been sent them by Lord Irwin, in which he had alluded to the system of part-time instruction, which was already in operation in the Gas Industry. It was quite true, as Lord Irwin said, that in some industries time was not granted to students to carry on their studies in the day time, but in the Gas Light and Coke Company, and in connection with many other gas undertakings throughout the country, such time was given, and students were paid for that time. Therefore, the principle suggested by Lord Irwin as desirable was already being carried out by them, and they could only hope that in the course of time it would become universal.

9th Report of the Gas Education Committee—1931-32

Sir FRANCIS GOODENOUGH, C.B.E. (Chairman of the Committee): I have the honour to present to you the report of the Education Committee, and I feel very real pleasure in doing so, because I think the results which the report embodies are very satisfactory.

We are now working under the revised scheme, the revision having been completed, as the report states, in 1929, but there has been one very important alteration since then; it is that the Diploma in Gas Engineering (Supply) has taken the place of the Diploma in Gas Supply, and by that alteration it will admit the holders to corporate membership of the Institution, if the other conditions under the by-laws are fulfilled. That is a very important and very satisfactory alteration in the regulations, as it was a very real drawback that the Diploma in Gas Supply did not qualify the holder for membership of the Institution.

The report tells a story of very considerable progress; an increase of 37% in the number of candidates examined under the Major Scheme, and of 37 and 35% respectively in Gas Supply Practice and Gas Fitting are very satisfactory figures, because they are percentages on figures which in themselves represented a considerable advance on the previous year. There is a steady progression in the number of students under the scheme, and I am sure that that is most satisfactory to you all.

It is very fitting that the report of the Education Committee should be brought into the programme of the Autumn Meeting, because the connection between education and research is very obvious. The report makes reference to closer co-operation between the Institution and the District Gas Education Committees, the educational unions, the technical colleges and the teachers throughout the country, and that is also very satisfactory. The International Congress of Commercial Education, which was held this summer in London, emphasized very emphatically the importance of increased co-operation between employers, on the one hand, and educationists, on the other, in order that the latter may the better provide for the real needs of the former; I think we can say that the Gas Industry is an outstanding example, if not the leading example in this country, of adequate co-operation between the Industry, on the one hand, and the educational authorities and teachers, on the other. I think we may congratulate ourselves upon that fact.

SERVICES RENDERED.

In that connection I should like to refer to the great services which have been rendered to this Industry and to the cause of co-operation between employers and educationists by Mr. A. Abbott, of the Board of Education; at least, he was with the Board of Education until yesterday, when he retired. I should like the Institution to place on record its appreciation of the very valuable services which Mr. Abbott has rendered to the Education Scheme of the Institution from its very inception, and the very valuable part that he has played in being the chief liaison officer between the Institution and the Board of Education and the educational authorities throughout the country. I am glad to say that there is every hope that Mr. Abbott's services will not be lost altogether. We wish him health and happiness in his retirement.

While speaking of officers of the Board of Education I should like to refer also to the valuable services of Mr. C. H. Creasey, who is a vital force, as every member of the Education Committee knows, in carrying out the Education Scheme. The courses for teachers, which are held each summer under Mr. Creasey's direction, have been of the very greatest value to the teachers and, through them, to the students in the Industry. We are very much indebted to Mr. Creasey, and we hope it will be a long time before we lose his services.

Speaking of thanks due, I should like to refer particularly to the work of the Board of Examiners. Examining is a very hard job, very keenly and zealously performed by a Board of voluntary workers, to whom the Gas Industry owes a very great debt, and as Chairman of the Committee I should like to say how much we appreciate the work of the Board of Examiners; I know you all appreciate it also. Again, the work of the District Education Committees is of great value, and we should like to tender our thanks to them for their assistance.

Last, but by no means least, in referring to services rendered, I should like to say how much we owe to Mr. Alexander for his work in connection with this Education Scheme.

The report can be summed up by saying that great progress has been made and is being made.

I have pleasure in proposing the adoption of the report of the Education Committee.

The PRESIDENT: I beg to second the resolution for the adoption of the report. I am sure we shall all endorse every word that Sir Francis has said with regard to our indebtedness to Mr. Abbott, and on the occasion of his retirement I am sure we shall all wish to place on record our appreciation of the very excellent services that he has rendered to us and to the cause of education in the Gas Industry. We are also indebted to Mr. Creasey, and especially to the Board of Examiners, who do a lot of hard work behind the scenes, and, I am afraid, do not get the credit they should. We are also very much indebted to Sir Francis Goodenough for all that he has done in connection with this work.

Mr. A. ABBOTT, O.B.E., M.A.: Charles Lamb says that when actors get a day off they always go to the theatre. This is the first free day I have had from my work in connection with education for forty years or thereabouts, and I celebrate it by coming to a meeting dealing with education. First I should like to thank you very heartily for the kind words that have been uttered and for the kind way in which they have been endorsed. I have enjoyed my work in connection with the Education Committee of the Institution of Gas Engineers. This Committee differs from all others that I have had anything to do with at the Board of Education, in the fact that it is not merely an English Committee; yours is the only body, so far as I know, which has representatives from Scotland, and from the Irish Free State and Ulster, and we all live very amicably together. Again, one of the things which the Board of Education is greatly concerned about, and which I think a great many people who deal with technical education in the country are concerned about, is the desirability of technical education being regarded from a regional point of view—*i.e.*, it should be looked at from the point of view of the industrial areas rather than from the point of view of single local authorities. In an area such as Lancashire and Cheshire there are probably twelve or fifteen local authorities, but I think there is no doubt that in future Lancashire and Cheshire will have to be regarded as a single region, making provision as a single unit for the technical education of people engaged in the industries of that region. Exactly the same will apply to other great industrial areas. You have gone some distance in the direction of approaching the thing regionally, through your local associations. You have at the centre the Education Committee of the Institution, which is a national body. It is constituted of members of your Institution, and is assisted by people who have knowledge and special experience of education. So in the country you have your local associations, which are constituted in a similar way and which can apply the policy (framed at the centre) in these great areas, taking account of local circumstances and conditions.

NEEDS OF THE CRAFTSMEN.

Further, you are taking special account of the needs of the craftsman. That, I believe, is something which other industries also will have to do more and more. Quite recently one of my colleagues and I spent some time—a good many weeks—seeing schools on the Continent. We saw them in France, Belgium, Holland, and Czecho-Slovakia and we were enormously impressed by the comparatively great amount of attention bestowed on the needs of the craftsman. In the past technical education has been to a large extent something for the ambitious person, the person who was anxious to rise and to become an official of some kind, and we have rather tended to neglect the needs of the craftsman. Therefore, it seems very satisfactory that the Institution of Gas Engineers should have spent as much time and attention as it has on the needs of this particular type of worker—the man who is anxious to excel, but to excel in a particular way.

I have been connected with your Education Committee ever since it started, and I think the Institution has every reason to be satisfied—certainly those at the Board of Education are satisfied—with the work that has been done. There was this year an increase of 37% in the number of candidates; it is not so much an examination that one cares

about as the fact that 37% more people have undertaken serious studies.

Finally, I should like to express what I know Sir Francis and the other members of the Education Committee feel—our sense of indebtedness to my colleague, Mr. Creasey. It is quite true that I attended meetings for some years very regularly, but the man who really did the spade work from the side of the Board of Education is Mr. Creasey, and he has put an enormous amount of energy and ability into the business. I must not forget Mr. Hole, with whom we have had the happiest relations during the whole time he has been connected with us.

Mr. JOHN TERRACE (Past-President of the Institution, and a member of the Education Committee): I should like to say that the shortness of the report is no measure of its importance. Knowledge is power, and I think the importance of the efforts of the Institution of Gas Engineers in providing an education scheme for those connected with the Industry cannot be overstressed. Therefore, I make no excuse for appealing to all those who are in a position to influence those entering the Industry, and especially those just leaving school, to do everything possible to get these young people to take advantage of the Scheme. While the regulations are somewhat complex, the Scheme itself is really very simple. At as many centres as possible throughout the Kingdom there are what we call internal group courses, and where those are available they form the most ready means. But it is not possible for an industry such as the Gas Industry, which is spread over such a wide area, to have these centres within reach of everyone. However, even where those centres are not available, technical colleges provide classes in the ancillary subjects at least, and where they do not have classes of the requisite standard, arrangements can very often be made whereby students can obtain the education they require. The 1929 regulations, however, made it possible for everyone, no matter in how isolated a position, to be able to take the examinations. While on account of the complexity of the regulations it may not be possible for everyone in charge of an undertaking to know quite all the details, the matter is really quite simple, because, now that we have the District Education Committees, all that the persons who are trying to press the youngsters to come into the Scheme have to do is to refer those youngsters to the District Committees. These are live bodies; they know the regulations and they know the local education conditions; they know what may be taken, and how it is to be taken, and their advice is available to everybody who requires it. The most recent provision, whereby those who take the Diploma in Gas Engineering (Supply) are able to enter corporate membership of the Institution, has been mentioned. The examination results give grounds for great satisfaction, but the Examiners' reports show that in some cases a certain amount requires to be done yet in raising the standard. To me the most gratifying thing in connection with the Gas Fitting Course is that, while there was an increase of 35% in the number of candidates in the whole three grades, the increase in Grade I. was 50%, and I would suggest to Mr. Abbott that we in the Industry are doing our bit in trying to induce as many as possible of our gasfitters to graduate as craftsmen. While there may have been an increase of 35% in numbers, however, the numbers are not yet really large enough, and I hope that everyone able to bring influence to bear on those entering the Industry will do so on behalf of education.

A STEP IN THE RIGHT DIRECTION.

Mr. J. H. CANNING, O.B.E. (Past-President of the Institution, and a member of the Education Committee): I agree absolutely with what Mr. Terrace has said, and support him most heartily. I consider that the opening of membership of the Institution to holders of the new Gas Engineering (Supply) Diploma is a step in the right direction; I am sure that it will stimulate interest in this examination. Up to the present very few entrants have come forward, but I sincerely trust that in the future more will avail themselves of this new departure, which departure is all the more valuable, I think, because the Education Committee has not in any way stiffened the examinations for the ordinary and higher grade. These latter are still open for aspirants who do not wish to proceed to membership of the Institution, but to whom the examinations will be useful in obtaining appointments.

Another matter mentioned in the report, and which I should like to emphasize, is that up to the present the employees of gas contractors do not appear to have realized that they are eligible for entry to these examinations. I know it is the wish of the Council that they should come forward in greater numbers than they have done hitherto.

Then there is another matter which I consider to be of the utmost importance to the success of the Scheme, and to each individual candidate. The Board of Examiners report inability on the part of many candidates to answer questions concisely and definitely, and also a lack of familiarity, we will say, with sketching, grammar, and spelling. I think we all agree that a sound general education must be the foundation upon which the technical training is based, and this is a very serious matter. I hesitate to speak upon it, but it is a fact which has become evident during recent years to a great extent, and even the greatest educational experts differ with regard to the cause of it. Some people say, of course, that it is due to the lack of the old classical education. I am not going to discuss the thorny question of the classical versus non-classical education, but I may venture the suggestion that the old classical education had a disciplinary effect, and was a sort of mental drill which prevented slovenly thinking—and I believe that slovenly thinking is at the bottom of a great deal of the troubles of to-day. Other people say that the trouble is due to the overloading of the educational curricula, and various other reasons are given, but I should like to suggest that it is part of the revolt which has, I must say, very rightly, taken place against the traditions of the Victorian era, with their inhibitions and repressions. Perhaps I might suggest that we have gone a little too far in shedding the tradition of the past, and that if we could adopt again that which is good in it, and make a reasonable compromise, in all probability some of these difficulties would be removed.

I should like to pay a tribute to Mr. Abbott, Mr. Creasey, the Examiners—I cannot pay a tribute to the Committee, because I happen to be a member of it—and to the Chairman, Sir Francis Goodenough, who has done wonderful work. I trust that he will receive the hearty support of everybody connected with the Institution in still further improving and perfecting this Scheme.

The PRESIDENT: There are other gentlemen who wish to speak on this report, but there is no further time for discussion now, and I should be glad if they would submit written communications.

Mr. STEPHEN LACEY (Gas Light and Coke Company), in a written communication, stated: I intended to speak this morning on the Report of the Gas Education Committee, and am glad to avail myself of the President's invitation to put what I wished to say in writing—as the discussion had to be cut short to enable the programme for the morning to be carried out as arranged. The comments I have to make on the Report are from the distribution and utilization points of view. It is true that the Institution and the Industry as a whole have reason to be proud of the progress that has been made since the Scheme was started nearly ten years ago. The machinery is in good working order, and the difficulties in regard to the "isolated" students have been largely overcome. Therefore, I think the time has come when we should measure our annual achievement, not so much in terms of percentage increases over the previous year in the number of successful candidates, as in relation to the total number of salesmen required by the Gas Industry with a sound elementary technical knowledge. I am confident that the Chairman of the Committee, Sir Francis Goodenough, will thoroughly endorse this view. To my mind the Ordinary Grade Certificate of the Major Course indicates the minimum standard of technical knowledge that should be reached as soon as possible by all young men who are gas salesmen, or on the road to becoming gas salesmen. There is, we know, much more required of a salesman than mere technical knowledge, but the fact remains that a gas salesman without the necessary minimum of soundly based technical information cannot be relied upon to serve the public and the Industry satisfactorily no matter how well qualified he may be in other ways.

Ninety-four candidates passed the Ordinary Grade Gas Supply Examination, either first or second class. That, at first sight, seems fairly good. But look a little closer and you will find that 61 of the 94 were attached to centres in the London district, and again only 7 centres were responsible for the remaining 33, although there are 20 centres outside the London district that have an approved Course. If we accept a rather lower standard as being sufficient in some circumstances, we shall also take into account the centres that have a Gas Supply Practice Course (there are 5 such outside the London district), and we shall add to the 94 successful candidates in the Ordinary Grade Examination 61 who passed the Gas Supply Practice—155 in all.

MORE STUDENTS NECESSARY.

Now the question is this—Do we think that an annual addition of about 150 salesmen holding the Ordinary Grade or Minor Course Certificate is sufficient for the country as a whole, especially having regard to the fact that about two-thirds of those obtaining the Certificates are in the London district? I suggest that the answer is obviously

"No," and that if the number were doubled next year it would be small in relation to the needs of the Industry. In my opinion, there should be very many more students taking the Gas Supply Courses than the Gas Engineering Courses, and that is not so to-day. The fault does not lie with the young men in the Industry who, in my experience, will gladly spend a considerable part of their leisure in attending classes and working at home, if they are given the right sort of encouragement and the necessary facilities. The fault, I make bold to say, lies with those in responsible positions who even yet do not realize how urgent is the need for a large increase in the number of properly qualified salesmen. If anyone were to say that I exaggerate the importance of technical qualifications, implying that a gas salesman is in greater need of commercial training, my answer would be that the gas undertakings who attach importance to technical training are precisely those that have supported the B.C.G.A. Scheme.

Now may I be allowed to say a few words about the Higher Grade and Diploma Courses? In my opinion the Ordinary Grade Course is sufficient for a large proportion of the gas salesmen, and it is a mistake for a salesman to swallow more technical information than he can digest and make full use of in his daily work. My view is that if we make sure that we have an adequate supply of salesmen holding the Ordinary Grade Certificate, there will be no lack of ambitious students willing and anxious to take the Higher Grade Course. I welcome the changes that have been made in the regulations with regard to the Diploma in Gas Supply, in future to be called "Diploma in Gas Engineering (Supply)." This Course is designed primarily to meet the needs of the industrial gas salesmen, potential distribution superintendents, and others requiring a relatively high degree of specialist technical knowledge securely founded on a broad basis of what we call ancillary subjects, and I hope that those possessing the Higher Grade Certificate, First Class, working to obtain the Diploma, will take the Course as laid down in the new regulations.

Sir FRANCIS GOODENOUGH: With regard to Mr. Canning's remarks concerning general education, there is another aspect of that matter which the Industry should bear in mind—that is, the importance of recruiting the young men for the future service of the Industry from perhaps a rather better or higher rank of education than has been the practice in some undertakings hitherto. Get better educated material into the Industry to start with; then you will not have this trouble concerning the lack of general education on the part of the young men coming forward. The secondary schools and the public schools of this country are producing a large flow of really well-educated young men, well grounded in general education, of whom the Industry might make better use than it does, by offering better prospects of pay and promotion than are offered at the present time.

The report was adopted.

Planning of Gas Installations to Conform with the British Standard Specification for Street Lighting

F. C. SMITH

Mr. F. C. SMITH, introducing the report, said: In the paper it is stated that the "B.S.I. Specification has been taken without comment and schemes have been arranged to fit its requirements. The author believes that the Committee responsible for drafting this Specification would not claim finality for it, and it is within his knowledge that efforts have been made from time to time to revise the Specification to make it a more equitable basis for tender, and to ensure that schemes that result from its application shall promote the highest visibility in the streets."

The Specification has been criticized from many points of view. There are those who regard it as too complicated to be of practical service, and others who are not sure that its provisions are adequate to ensure good visibility in the streets. In regard to visibility it must be confessed that many of the factors influencing this are as yet imperfectly understood. Indeed, if two equally competent public lighting engineers were asked to express their opinion as to conditions necessary to promote the highest visibility in a given thoroughfare their opinions would probably differ materially the one from the other, and this is to be expected in view of the present state of our knowledge of the subject. Moreover, if two given thoroughfares were lighted in different ways experienced observers would undoubtedly have different ideas as to the relative merits of the lighting of each thoroughfare. The lighting of a public thoroughfare in a manner to give general satisfaction is a difficult matter, but I believe that if we rely upon rule of thumb or rough and ready methods the results obtained are bound to lead to disappointment in the great majority of cases and are likely to prejudice the standing of the particular industry that adopts such methods.

It is made clear in the paper that there is no attempt to comment upon the present Specification, although those responsible for it would agree that it leaves much to be desired. It is important, however, to remember that the Institution of Gas Engineers has accepted the Specification as it stands and is responsible together with other interested authorities for the drafting of the Specification. It is hoped that as experience is gained it will be possible to improve the draft of the Specification in order that it may become more effective in promoting the highest visibility in our streets. It is worthy of note that the difficulty of drafting such a specification was emphasized when the representatives of all the nations taking part in the International Illumination Congress last year met in order to discuss a specification for street lighting. Men whose experience and knowledge of the subject demanded respect were unable to agree even upon the fundamentals of some of the clauses which should form a street lighting specification.

The practical point, however, is this, that the B.S.I. Specification is the only generally recognized specification in this country; and it is therefore becoming a much used basis for tendering for public lighting. It is therefore practical politics that the Gas Industry should thoroughly understand the Specification as it stands to-day, and have schemes available that tenders may be submitted to inquiring authorities.

It has been stated that the Specification is too complicated and that both public lighting and municipal engineers find it difficult to understand some of the provisions of the Specification and to assess the relative merits of schemes submitted to them for the lighting of given thoroughfares. This criticism has something to support it; and it follows that until the question of visibility is thoroughly understood it must always be difficult to assess the merits of two schemes. It is the opinion of many, however, that if an isolux diagram for the lighting of a given thoroughfare is submitted with the tender it is much easier to assess the relative merits of two schemes. Some surveyors may have had little practical experience of lighting problems, but they are all familiar with contour maps, and the close resemblance in principle between contour maps and isolux diagrams should enable the latter to be readily appreciated. If it is desired there is no reason why a plan of the road should not be divided into a number of equal squares, and the value of the illumination upon each of the squares indicated by a figure.

RATING OF STREET LAMPS.

A great difference of opinion exists between lighting engineers as to the correct method of rating the candle-power of street lamps. The electricity industry commonly rates the candle-power of a street lamp in terms of mean spherical candles. Sometimes the mean spherical candle-power of the light source enclosed within a suitable lantern is given and at other times the mean spherical candle-power of the bare light source is quoted. It is urged by those who agree with this method of rating that it is a simple matter to compute from such a rating the total luminous flux from the source, and it has been suggested on occasion that candle-powers quoted in terms other than the mean spherical candle-power lead to false conclusions.

It is apparent that should it be desired to compare the candle-power of two sources it is essential that the candle-power of both sources should be stated in the same terms,

but it is by no means proved that the mean spherical candle-power is the only satisfactory method of rating street lamps, or, indeed, that it is the most satisfactory method. On the contrary, many very good reasons can be advanced in favour of stating the candle-power of a street lighting unit in terms of mean lower hemispherical candles.

In the paper under consideration data are given which enable the candle-power of street lighting sources to be computed in a manner thought most desirable by those making use of the data. A curve showing the distribution of light from each source is given, the flux in lumens in the lower hemisphere is stated, and from these may be calculated the lower mean hemispherical candle-power. In addition the total flux in lumens is quoted, and from this figure the mean spherical candle-power may be obtained. Also, the gas consumption and calorific value of the gas are stated. The distribution curve enables the candle-power at any desired angle with the vertical and any corresponding azimuth angle to be computed, and this is necessary in estimating the illumination to be obtained at the test point. It should be understood clearly that in specifying for the lighting of a street to comply with the B.S.I. Specification either party to the contract is not directly interested either in the mean spherical candle-power, lower mean hemispherical candle-power, or in any statement as to the candle-power of the source. The contractor is asked to ensure a given illumination at the test point; and this illumination must be the minimum on the road surface. The contracting party must use units and adopt a spacing height ratio to obtain results which comply with these requirements. It must be noted, however, that a knowledge of the distribution of light from the light source is essential in order to calculate the resultant illumination at the test point for any given set of factors. It is therefore essential that some form of distribution curve giving the intensity of the candle-power in any direction around the source shall be available.

It sometimes happens, however, that authorities are asked to quote for public lighting in terms of providing a certain number of sources of definite candle-power; and it must be appreciated that the term "candle-power" is without significance unless it is defined. It is well to remember that the latter method of contracting is outside the provisions of the B.S.I. Specification. It is sometimes stated that some lighting authorities when quoting on the basis of candle-power do not define whether they are quoting on the basis of mean spherical, mean lower hemispherical, or maximum candle-power at a given angle. In my opinion, quoting on the basis of mean spherical candle-power is not desirable.

The object of street lighting in the main is to promote visibility in the streets, and the only index to this at the moment in terms of the Specification is the horizontal illumination. It is certain that, provided a source has a reasonable distribution, a large proportion of the light in the lower hemisphere will reach the road surface. If the mean spherical candle-power is taken as the basis, then the ratio of the light in the upper hemisphere to that in the lower will vary according to the type of fitting used, and it is difficult in the absence of a distribution curve to assess the amount of light that can be utilized to illuminate the road surface.

While it is urged that defining the candle-power in terms of the lower mean hemispherical is of more value than stating it in terms of mean spherical, it must be admitted that both statements are inadequate if the lighting of the thoroughfare is to be properly designed. I feel that a distribution curve of the lighting unit it is proposed to use should always accompany any tender.

The Value of the Isocandle Diagram.

I think it will be agreed that if the lighting of a thoroughfare is to be carefully designed a knowledge of the distribution of light from the source chosen is essential. The familiar form of polar diagram was adequate when sources had a symmetrical distribution about a vertical axis, but now that directional reflection is so often used many light sources have not this symmetrical distribution. It therefore becomes necessary to have some form of diagram that will give the candle-power in all relevant directions, and the isocandle diagram in some form or other does supply this need.

The B.S.I. Specification states, however, that the contracting party may be required to state the average illumination over the carriage way and on the foot-way. The sinusoidal projection of an isocandle diagram enables the average value for the horizontal illumination to be calculated readily. In addition the calculation of total luminous flux both in the upper and lower hemispheres for asymmetric sources is a simple matter if use is made of this diagram. The value of an isolux diagram has been referred to already. It is probably the easiest method of representing the distribution of light over the road surface. The isocandle diagram on sinusoidal projection is really a useful tool which enables average illumination to be calculated readily and an isolux diagram to be prepared.

A Lucid Description.

Mr. Robert Watson: Those who have thoroughly studied the paper which has been prepared by Mr. Smith must have realized the vast amount of work that he has put into it, and the extraordinary amount of thought he must have devoted to the subject, and must have appreciated the lucid description he has given of the problems of street lighting. We are very greatly indebted to him in consequence. Our thanks are due also to the Governor and the Court of Directors of the Gas Light and Coke Company, who have so willingly placed the facilities of Watson House at the disposal of the Joint Lighting Committee for the purpose of obtaining material for the paper.

The paper was presented to the Association of Public Lighting Engineers at its meeting in Blackpool last September, and I believe it did a great deal of service to the Industry in showing how well and thoroughly gas can conform to the requirements of the Specification. A paper on somewhat similar lines was given then in the interests of the electrical industry, as a result of this paper; as soon as the electrical interests knew that this paper was to be submitted, a similar paper was prepared, dealing with the electrical side, by Mr. Wilson. It is very pleasing to note that both authors were careful to avoid comparisons of the two illuminants; each kept to the subject of his paper, and dealt with it thoroughly in the interests of his own industry. That is an attitude very much to be desired; one rather deprecates the attempts that have been made recently to belittle one illuminant by quoting exceptional cases and mis-using data obtained with regard to it. I am glad to say that in the Specification Committee there is no controversy of this sort; the problems of street lighting are discussed fairly and without prejudice, and the Chairman has set an extraordinarily good example by his strict impartiality and friendly criticism of the points raised.

The Specification of 1931 has been adopted, although it is recognized that it is not perfect, and it has not reached finality. We are accumulating further data as the result of the use of that Specification, and we are all hoping that the experience and data now obtained will be of service in the revision of the Specification which is now taking place. Personally, I was not dissatisfied with the Specification of 1927, with its simple and convenient method of appraisement of street lighting; the criterion of that Specification was the minimum horizontal illumination at a point or points specified, but with certain safeguards. The Specification stipulated that there should be minimum mounting heights, maximum height-spacing ratios, the illumination from the post to the mid-span point should be graduated, but no illumination at any other part of the span, between the column and the mid-way point, should be less than that of the specified test point. In tendering, distribution curves were to be supplied, showing the distribution of light over the road surface. On top of that, the purchaser was enabled, by the Specification, to select other test points if he so desired. So that to my mind every precaution was taken to ensure that the minimum test-point illumination should not be abused. Unfortunately, the safeguards were ignored in many cases, and we found that there were attempts, by means of asymmetric fittings, to concentrate or focus light upon the specified test point, to the disadvantage of the rest of the road surface. It was for the purpose of meeting the criticism advanced in that respect, and the suggestions made by all interests, including the gas interests, that a further stipulation was made; it was that average illumination should be included in the Specification, or, at any rate, declared by those who were tendering to this Specification. The adoption of average illumination in addition to the minimum horizontal illumination criterion brought about certain difficulties, and one was its complication. Clause 28, Section B, of the 1931 Specification is worded so that the purchaser may be able to settle with the tenderer a method for the computation of average illumination. The Specification Committee put forward one method (which is detailed in the appendices to the Specification) by which average illumination could be calculated. Mr. Smith has rendered us very great service by explaining very lucidly how that method can be used, and we are delighted that he has been able to serve us in that way.

Where the Trouble Arises.

I have suggested that it is open to the purchasers to come to an agreement with the tenderers as to how average illumination should be calculated—that the sinusoidal isocandle method of computation need not be adopted if

they can find a better—and that is where the trouble comes in. If you study the Specification carefully you will find that no lighting authority is obliged to adopt all the clauses in the Specification, but they can adopt such sections as suit their purpose. It is perhaps questionable whether the Specification has been adopted in many contracts to date, but I do not think that matters much so long as the guidance of the Specification is accepted. It has served a very useful purpose, not only in the electrical industry, but in the Gas Industry also, in helping to improve existing installations, and one has realized, when travelling about the country, that many members of this Institution have adopted the suggestions of the Specification, not only to the advantage of the installation itself, in effecting better visibility, but also to their own advantage in meeting competition. That is all to the good, and I would strongly commend a further study of Mr. Smith's paper. If one is not disposed to study too closely Appendices 1 and 2, which deal with the more scientific side of the problem, then by studying at any rate the photometric data in Appendix 1 and the extraordinary number of schemes detailed in Appendix 3 (incorporating known and used gas lamps), and by adopting the suggestion as to good maintenance, coupled with the use of a well-designed governor, I am sure the results accruing will be to the satisfaction of those who have to deal with street lighting by gas.

The PRESIDENT: I am sure we all thank Mr. Watson, not only for his contribution to the discussion this morning, but for all his work in connection with street lighting by gas. We thoroughly endorse what he has said with regard to our indebtedness to the Gas Light and Coke Company, who placed the resources of Watson House at the disposal of the Committee, and Mr. Smith has done great service to the Industry in producing this paper.

Bt.-Col. W. M. CARR, M.C. (Stretford and District Gas Board): It would be interesting if Mr. Smith would tell us the particular instruments and the light standards that were used in drawing up his diagrams. My difficulty has been to get the surveyors, in the area supplied by the undertaking which I serve, even to look at the British Standard Specification, and it does appear that we have a great deal of educational work to do throughout the length and breadth of the country before we shall be in a position to get the local authorities to demand tenders on the basis of the British Standard Specification. Possibly the Lighting Committee will in due course give consideration to steps which can be taken in addition to those already taken, and in addition to the very excellent work which has been done through the Illuminating Engineering Society. We must try, possibly through Government sources, to bring influence to bear on local authorities to adopt the British Standard Specification, because until they do understand and adopt it there is little chance of our being asked to tender on the basis of it.

Mr. C. A. MASTERMAN (Gas Light and Coke Company): One gathers that there is a great deal of criticism of the B.E.S.A. Specification, and it is a Specification which it is very much easier to criticize than to put right. My own feeling is that a specification of that sort, which has to be used by all kinds of interested authorities—gas and electrical undertakings, public authorities and maintenance authorities—ought essentially to be very simple, and I do suggest that the criticisms of the Specification are rather uninformed, in that the people making the criticisms very often have not read the Specification sufficiently carefully to appreciate what it is driving at. The essence of the Specification as it is at the moment is to give for certain classes of streets certain mounting heights and certain minimum horizontal illumination. The complications which arise are in the testing out, and the fact that the testing out is complicated is the fault of nobody; it is a matter of natural science, and one cannot help it. I think that any Specification that one can anticipate is bound to have fairly complicated testing clauses.

Mr. Smith attempts to give a lead to the Gas Industry in going through the complications of testing and design, and to provide data with regard to the light sources and the streets he mentioned; once this information is obtained by one person it can be applied throughout the Industry, so that it is not necessary for a number of other people to do the same work again. It is very unfortunate that there was not time to get as far as the isolux diagram, which is so simple, and which can easily be understood. The last stage, from the isocandle to the isolux, remains to be completed, but it is a very simple stage. However, the paper, if properly studied, should be of very considerable use in future in the carrying out of gas lighting installations. After all, whether we like it or not, these things have undoubtedly to be planned out in the future in a way in which they have not been worked out in the past.

Second Report on the Back-Run Process for the Manufacture of Carburetted Water Gas

Research Chemist: F. J. DENT, Ph.D. *Research Assistants:* W. H. BLACKBURN, Ph.D., N. H. WILLIAMS, M.Sc., E. PARRISH, M.Sc.Tech., and A. R. KELLY, B.Sc.

Mr. H. HOLLINGS (Gas Light and Coke Company): In opening the discussion upon this Report I want to urge that it should be read not only in conjunction with the 27th Report, but also in conjunction with the 10th Report, which describes the test made upon a bricklined generator at Birmingham by Dr. Parker. It appears to me that only in this way can this back-run process be viewed in proper perspective. It is very significant that the best of the results obtained by Dr. Parker with the bricklined generator compares favourably with the results of the back-run process now under discussion.

I should like to add that, apart from this plant at Nine Elms, we have drawn up in considerable detail the heat balances for several of our water gas plants, some of them bricklined and some of them with generator boilers, some with and some without the back-run. We have also been very much impressed by the fact that when we have corrected the results to a uniform basis of 15% ash *plus* moisture in the coke, and when we have adjusted also for differences in the amount of oil used for carburetting, the thermal efficiency of blue water gas manufacture in the best of our bricklined generators is as high as it is in the generators fitted with some of the modern improvements. For example, our test result for the bricklined generator without back-run is 74·3 therms in blue water gas per 1000 lbs. of coke, having 15% ash and moisture. Dr. Parker's result at Birmingham was 73·9 therms. Dr. Dent's results obtained with the back-run process are 66·5 therms in Test 1 and 75 therms in Test 2.

Now there are undoubtedly advantages in these recent modifications in the design of water gas plant to be seen in the increased rate of gas output for a given plant, in the decreased amount of labour required, and in the greater uniformity of working. When we come to the question of thermal efficiency, however, I think we are forced to the conclusion that the savings to be secured are no greater than the variations in efficiency which may result from differences in the technique of handling a plant of either old or new design. In his discussion of the results Dr. Dent makes several references to the relationship between the efficiency of working and the cycle employed, or in some cases he refers to the condition of the fire. This condition of the fire is surely in turn dependent upon the cycle.

It may be that the superiority of the result obtained in Test 2 over that obtained in Test 1, is due to the saving which must have resulted from the decrease in the blow period. Be that as it may, the existence of such a difference and the relationship between these two results and those obtained in bricklined generators suggest that a much more intensive study should be made of the efficiency of water gas manufacture as affected by variations in the conditions of blowing rather than by variations in the conditions of the run.

VALUE OF RESEARCHES.

Mr. C. A. CUNNOLD (Station Engineer, Nine Elms Works, Gas Light and Coke Company): I wish to thank Dr. Dent for his kind appreciation of the assistance given to him by

the staff at Nine Elms, and to congratulate him upon presenting to this meeting the most interesting report upon water gas manufacture yet laid before this Institution.

I also desire to say a few words upon the value of the Institution Researches to the staff at the works upon which they are conducted. Details and small points are thought out and tested in a way which would not be attempted under ordinary workaday conditions, and there is no doubt that the research now under consideration stimulated the interest of our staff and permanently improved some of our working results at Nine Elms.

I am sure that the work which is being carried out year after year by the Research Staff so enthusiastically will be regarded in time to come as one of the best means devised by this Institution for obtaining for the Industry accurate and comprehensive technical data.

Now, as regards the 31st Report, my remarks will endeavour to present to you the point of view of the users and operators of water gas plants. For them the main consideration is how far can the results obtained by Dr. Dent be realized in everyday working. It is all very well for the analyst to throw away the water content of the coke; to separate the coke into carbon and ash and ignore the ash. But in the actual manufacture of water gas those responsible for the operations can only reduce the moisture and ash content of the coke to a very limited extent. The coal purchased decides the ash content and the moisture cannot be altogether eradicated, so that we are not likely to obtain in actual working the full reduction in coke consumptions given by Dr. Dent in his conclusions in the Report.

I should, however, certainly expect to get, when using back-run steaming, a net reduction in the coke figure over down-run steaming of about 3 lbs. per 1000 c.ft. of gas made, provided that the calorific value of the gas made was round about 390 B.Th.U. per c.ft. This agrees with the result we usually obtain at Nine Elms, where the calorific value of the carburetted water gas made is frequently about 390 B.Th.U. per c.ft.

A test made under working conditions at Nine Elms by our Staff, working in conjunction with some members of the staff of Messrs. Humphreys & Glasgow in February, 1927, confirms this statement. But with regard to the manufacture of C.W.G. of 490 B.Th.U. per c.ft., there is little doubt that we can get similar results as regards output, oil figure, and coke used per 1000 c.ft. of gas made, whichever steaming method we use—*i.e.*, whether we use down-run or back-run. The chief reason for this is well known to all users of both methods—the limited period of time available for admission of oil during the cycles worked with back-run steaming.

To repeat, my experience is we definitely prefer back-run steaming for calorific values round about 400 B.Th.U. per c.ft. and we do claim that we then get the advantage of a reduced consumption of coke of about 3 lbs. per 1000 c.ft. with an increased output per set per day, but with a reduced output of steam from the waste-heat boilers. We raise any steam required to replace this output in Lancashire boilers, breeze fired. When we require C.W.G. of a calorific value of 500 B.Th.U. gas, we are inclined to favour down-run steaming.

We have not had any trouble with back-run valves. They are examined regularly once a year. Our early troubles with corrosion of the back-run steel pipeline have been overcome by using cast iron. Coke is conveyed under cover by belt from a vertical retort house to the water gas plant, but during the test, to ensure accurate weighing, it was shot in the open near the water gas plant.

A Mine of Information.

Dr. J. G. King (H.M. Fuel Research Station) (Dr. King's manuscript was read by Dr. M. A. Matthews): In this report upon the " back-run " process for the manufacture of water gas the Research Committee are to be congratulated upon having produced a real mine of information. The report is not one to be read lightly—it requires a good deal of study—and I feel that it will find its greatest use as a work of reference for those engaged in the manufacture of carburetted water gas. Experimental work on the water gas process offers peculiar difficulties owing to the discontinuous nature of the process and the shortness of the time intervals over which observations must be taken. Dr. Dent and his staff have shown considerable ingenuity in overcoming the obvious difficulties of gas sampling and in making allowances for the variations of gas composition which interfere with the obtaining of true averages. They have, however, taken the laborious means of measuring the gas volumes of cycles, by 5 sec. observations, when they might have made use of the automatic apparatus devised for this purpose by King and Williams (Fuel Research Tech. Paper 27, 1930). This apparatus takes a continuous photographic record which, on development, gives the curves shown by Dr. Dent in figs. 15 and 16. It has practically no time lag, and movements of the gauge liquid are followed much more accurately than by eye. It is also rather unfortunate that in such careful tests as these arrangements were not made for the complete combustion of the blow gases.

The tests described in the paper are primarily a comparison between " back-run " and " down-run " steaming, and the authors appear to find in favour of the former. The back-run process was originally introduced to raise the efficiency of the generator by applying superheated steam for down-running. In the comparison before us the increase is not more than 2·3%, and there are differences in the experimental conditions of the runs which make even this doubtful. On carburetted gas, however, the differences are more marked, 3-4%.

In Test 1 it is shown that the comparison is spoiled to an extent by the greater consumption of coke during the blow than in the other tests. Certain experiments done recently at the Fuel Research Station are of interest in this connection. The fuel-bed conditions in a water-gas generator were kept uniform by making special arrangements as to distribution of coke and the supply of air, and by working between definite temperature limits, the upper limit being below the fusion temperature of the coke-ash. By these means it was possible to increase the process efficiency of water gas production about 10% and the overall efficiency about 7%. Similar arrangements as to the control of the contents of the generator would probably have greatly assisted such comparisons as those of this paper.

I should like to draw attention to one aspect of water gas manufacture which one seldom finds referred to, although it is of obvious importance. The component parts of the cycle of operations are of short duration and the volume of the generator (free space), carburettor, and superheater are appreciable in relation to the volumes of gas made in each part. Gas is, therefore, lost during purge periods, and blow gases are included in the gas during gas-making, both to an extent which it should be possible to reduce if greater attention were to be paid to the design of the plant so as to obviate turbulence in the gas flow and improve the efficiency of purging. This is a point more for the maker than for the user of plants, but it is one which would appear to repay investigation. I am not certain of my authority, but I have seen it stated that the percentage of hydrogen in the average gas can be increased by 2% without loss of volume. If this is so, the increase of efficiency is large enough to be worthy of the attention of the Research Committee.

Air Distribution in the Generator.

Dr. A. Parker: This report is certainly lengthy, but in spite of its length there are one or two points which I should like amplified, especially having regard to the 6th, 7th and 10th Reports; these dealt respectively with blue water gas manufacture, carburetted water gas, and, again, blue water gas. I know from experience that the carrying out of tests of this nature is extraordinarily difficult; attention must be paid to every detail if results worth anything at all are to be obtained. The process is not so simple as it might appear; all sorts of factors arise, affecting the running of the plant and the efficiency of manufacture of the gas and the output of gas per day. When it comes to attempting to measure the difference brought about by making what I should call a minor change in the method of running the plant—that is, superheating a portion of the steam only which travels downwards through the generator —then obviously it is necessary to control every condition as carefully as possible. Dr. Dent and his assistants have watched such points as sampling, measurements of gas, and measurements of coke most carefully, and I am convinced that, with the present knowledge and apparatus, they could not have obtained more accurate results than they have obtained in those respects. But to my mind two points have been omitted. I personally should have hesitated to measure the difference brought about with back-run steam as against down-run, unless I could have had the use of some form of positive blower which would deliver a definite volume of air in a definite time. A big factor in water gas manufacture—big in comparison with those measured in these tests—is the condition of distribution of the coke and of the ash in the coke, because with a change in distribution, even when the coke is graded carefully, the volume of air passing through the generator per blow period is automatically altered. In addition, the slagging of ash, the formation of clinker, not only adds resistance to the flow of air, but alters the path of the flow of air, and instead of the air being properly distributed over the whole of the generator it goes through some sec-

tions and misses others. Therefore, you must control the air properly, and the only way, so far as I can see, is to use a positive blower. Further, you must ensure, as far as is practicable, that coke of the same quality, and obtained by carbonizing the same coal, is used in each test, if you set out to measure the small differences which can be expected to result from superheating steam in the down-run.

I do not think that Dr. Dent and his assistants will regard my remarks as being in the nature of severe criticism. I raise these points as suggestions for the future, because work of this kind is difficult, and one can only learn as the result of experience of a number of tests.

Difficulty of Drawing Conclusions.

Great as are the difficulties of testing, the difficulties of drawing reliable conclusions from the results are even greater. I could argue for hours with Dr. Dent on some of the phrases used in the report, but I would like to illustrate my points. Before the two methods—back-run and down-run—can be compared, it is necessary to ensure that the very best conditions have been obtained for each method. That means that a number of trials must be made under different cycles. From the report we note that six tests were carried out—three with back-run and three with down-run. Two of the back-run tests resulted in making 490 gas, and one resulted in making 390 gas. Those making 490 gas were not generally used for the calculations. For example, test 1 (back-run) was rejected because it was decided that the conditions were not quite satisfactory. Test 2 (back-run) was accepted; test 3 (down-run) was accepted; test 4 (down-run) was accepted; test 5 (down-run) was rejected. I gather from the report that test 5 was really the tail end of test 4, but the measurements were split off because unsatisfactory conditions developed in the fuel bed. One wonders whether test 4 really represents the best conditions, if the last three days of what was intended to be test 4 had to be cut off and called test 5 because it was not satisfactory. Test 6 (back-run) was looked upon as not entirely satisfactory, because the conditions were the same as in test 1. So that we have only tests 2 and 4 in which the conditions are comparable, and the conclusions are based on the results of those two tests. We find that the differences in efficiencies were as follows:

In the manufacture of carburetted water gas, 0·9% in favour of back-run.
In the manufacture of blue water gas, 2·2% in favour of back-run, and 3·3% greater make per day with back-run.

But in comparing the two tests we find that the moisture in the coke used in the down-run test was nearly 4% greater than in the coke used in the back-run test; the CO_2 in the blue water gas in the back-run test was 5·1, as against 3·6 in the down-run; and there was a difference in the blow gas, indicating different conditions of cycles. These differences are small, and I think they are smaller than might result from changes in the nature of the ash in the generator; I doubt that one could get much closer results if one attempted to repeat the tests under the same conditions.

What is the effect of ash? That can be seen by comparing tests 4 and 5, which were presumably under the same conditions. Test 4 is a down-run test, and test 5 is a continuation of test 4. The differences in efficiencies in those two tests were:

In carburetted water gas manufacture, 0·8%.
In blue water gas manufacture, 3·2%.
Make of carburetted water gas per day, 7·9%.
Make of blue water gas per day, 8·1%.

These are differences bigger than those from which the conclusions regarding the relative merits of the back-run and down-run processes have been drawn.

Back Run for 400 Gas.

In spite of those criticisms, in reading through the report I have come to the conclusion that there is some advantage in the back-run process when carburetted water gas is being made with a calorific value not more than about 400 B.Th.U. per c.ft. The advantage appears to me to lie in smoothness of working and more even distribution of heat in the carburettor and superheater. But as regards differences in efficiency I am not so sure whether there is any advantage at all. Indeed, from the previous tests, dealt with in the 6th, 7th, and 10th Reports, I had rather come to the conclusion that, provided you experiment to get the right cycle of operations for a particular coke and a particular plant, there is very little to choose in regard to the maximum efficiency obtainable in any of the plants erected for the manufacture of blue water gas, and that one can get practically the same with vertical retort coke, horizontal retort coke, or coke-oven coke. It must be remembered that the superheating of the steam in the back-run process is not entirely a saving. The water gas reactions take place in only about the bottom 2-ft. of the fuel bed. Usually one uses a fuel bed of at least 6-ft. depth, so that the top 4-ft. of depth is really serving as a superheater for any steam passed downwards. Therefore, there is not so much saving in superheating steam outside the generator as one might at first imagine.

Analysis of Fuel Saving.

Dr. S. Pexton (Gas Light and Coke Company): The maximum saving in fuel resulting from the back-run process is shown by a comparison of Tests 2 and 4 in which the calorific value of the C.W.G. was about 400 B.Th.U. per c.ft. The consumptions of coke per 1000 c.ft. of B.W.G. in these two tests were 38·8 lbs. and 42·7 lbs. (corrected to a 15% ash and moisture basis)—in other words, an apparent saving of about 4 lbs. of coke with the back-run.

Let us analyze how this saving has been effected.

In Test 2, the amount of heat returned from the carburettor and superheater to the generator by the back-run steam amounted to 0·089 therm per 1000 c.ft. of blue water gas. In the down-run process, Test 4, an additional corresponding quantity of heat, therefore, had to be stored in the fuel bed by prolonging the blow. At the end of the blow period the temperature of the fuel bed rises relatively slowly; in other words, the blow is extremely inefficient, because such a large proportion of the heat of the carbon burnt passes away as potential or sensible heat of the blow gas, and also the rate of heat loss to the annular boiler is greater than at any other stage in the process. The additional heat lost to the annular boiler in Test 4, compared with Test 2, amounted to 0·026 therm per 1000 c.ft. of B.W.G. Together with the 0·089 therm superheated in the back-run steam in Test 2, this makes an additional 0·115 therm per 1000 c.ft. of B.W.G. to be supplied at end of the blow in Test 4.

From the analyses and temperatures of blow gas at the end of the blow 67% of the heat of the carbon burnt leaves the generator as sensible and potential heat of the blow gas. In other words only 33% remains to supply the 0·115 therm over 1000 c.ft. of B.W.G. The additional coke consumed in Test 4, compared with Test 2, should accordingly amount to 0·35 therm, or 2·9 lbs. of coke per 1000 c.ft. of B.W.G.

In other words a saving of nearly 3 lbs. of coke per 1000 c.ft. of B.W.G. can be attributed directly to the back-run process in Test 2. The difference between this value and the 4 lbs. actually observed appears to be due to a rather too short a blow in Test 2, as shown by the high CO_2 content of the blue water gas in this test, 5·1%, compared with 3·6% in Test 4. With the optimum cycle in both cases and when making C.W.G. with a calorific value of 400 B.Th.U. per c.ft., the saving in fuel resulting from the back-run process would therefore appear to be 2½ to 3 lbs. per 1000 c.ft. of blue water gas.

Another aspect of the problem which can be analyzed in similar manner from the results presented in this report is the effect of heat lost to the annular boiler upon the fuel consumption per 1000 c.ft. of blue water gas. The average quantity of heat lost to the annular boiler for these tests amounts to 0·4 therm per 1000 c.ft. of B.W.G. This heat is raised by the consumption of coke with an efficiency no greater than 40%. It follows, therefore, that the coke consumed to provide the heat passing to the annular boiler amounts to 8 lbs. In the absence of an annular boiler as in a bricklined set there is a loss of heat to atmosphere of 0·2 therm per 1000 c.ft. of B.W.G. which on the same basis corresponds to 4 lbs. of coke.

When making C.W.G. with a calorific value of about 400 B.Th.U., similar results for fuel consumption are to be expected from a boiler generator with the back-run and from a bricklined set.

The President asked that others who wished to contribute to the discussion should do so in writing, and suggested that Dr. Dent might prefer to reply in writing.

Report on Gases Met with Underground

The Holborn Explosion of 1928

Prof. J. S. HALDANE, C.H., F.R.S.

Mr. E. V. Evans (South Metropolitan Gas Company): I do not propose to congratulate Prof. Haldane on his paper. (My reason is that a college boy started his Greek paper by stating that Homer was much to be congratulated upon his Iliad.) But I do welcome the opportunity of expressing thanks to Prof. Haldane for a very excellent communication. The Professor does not wish to re-open the matter of the explosion in London, or to interfere in any way with the amicable settlement that was arrived at with regard to it, but he gives us the facts, and they may be of use to us on a future occasion—though I hope they are not.

The Gas Industry has not been very interested in micro-organisms. Within recent years, bacteria have been exceedingly unfriendly to the Gas Industry. They certainly served us a very useful purpose in the past, by carrying out what I think is known as the coalification of vegetable matter; moreover, the excellent condition in which is found the bog ore that we use in the purification process is also due to very industrious bacteria. But in recent years bacteria have changed their attitude entirely to the Gas Industry. In rivers and streams there exists an organism which is capable of absorbing sulphates in ordinary water and evolving in their stead hydrogen sulphide. This fact has caused gas-works chemists many sleepless nights. If holder water becomes infected with the disease—and this bacillus grows and multiplies at an enormous rate—it is really most troublesome, and, of the problems I have been associated with in the chemistry of gas manufacture, no one has bothered me so much as this has. I think that the means of dealing with hydrogen sulphide production are now established. It is interesting to note that the microbes do not multiply at such a high rate when naphthalene is present in the gasholder; thus, those who were first to take naphthalene out of the gas were the first to experience this difficulty. The organisms consume the sulphates of the water, and, peculiarly, the process we have chosen is to let them get on with the good work until they have absorbed the sulphates, and to keep in hand the hydrogen sulphide evolved while they are doing it, by the use of colloidal zinc oxide or zinc acetate. But when the sulphates disappear, the hydrogen sulphide also disappears. It was peculiar to find, in those very old tanks, which were really tight and which had contained water for a great number of years, that although the original water was river water, which must have contained an appreciable quantity of sulphates, there was no trace left; the bacteria had caused it to disappear entirely.

Mr. Stephen Lacey (Gas Light and Coke Company): Dr. Haldane's paper is of great interest and importance not only to those responsible for maintaining gas distribution systems, but also to those responsible for underground chambers, tunnels, duct lines, &c.—I have particularly in mind public utilities responsible for the sewerage, telephones, and electric services.

It will come as a surprise to many that inflammable gases can be generated underground by anaerobic fermentation, and that gases in the soil, either inflammable or suffocating, may be driven into underground cavities by changes in barometric pressure. It has sometimes been argued by those in charge of boxes and underground chambers on cable systems that the only reason for ventilation is the possibility of escapes of town gas, but Dr. Haldane's work shows that ventilation of underground chambers would be necessary even if there were no gas main in the vicinity.

A Subject of International Interest.

Some interesting research on methods of ventilation of chambers has recently been carried out in Paris, on behalf of the Paris Gas Company. This work was described in a paper entitled "Ventilation of Underground Spaces," which was read by M. Chappuis before the 3rd International Congress of Sanitation and Urban Hygiene in March last. The Report of the Commission on Distribution at the Meeting of the Congrès de l'Industrie du Gaz en France last June also dealt with an investigation of the general question of leakage of gas into cable ducts and boxes. I mention this as showing that the subject is receiving considerable attention in France at the present time.

Referring to the explosions in Holborn in December, 1928, I do not think I can usefully add anything to Prof. Haldane's summary of the evidence with regard to the source of gas which resulted in that explosion. I do, however, wish to stress the fact that the matter of damages was amicably settled between my Company and the Post Office, and that the engineers of the Post Office Telephone service are working in close co-operation with the officials of the Distribution Department of the Company in all cases where they come into contact.

As a result of the evidence given at the Holborn inquiry, it was realized that some more definite and more sensitive test of the presence of coal gas than the usual leakage indicator was desirable in certain circumstances, and a palladium chloride apparatus, which provides a definite test for carbon monoxide, was developed at Watson House. This apparatus is not normally used in searching for leakages—the usual form of indicator being more suitable—but it is used in all cases for verifying the absence of gas from boxes, &c., after a leakage into them has been remedied, or when there is any doubt as to the presence of coal gas—such as when "a smell of gas" has been reported but gas cannot be traced by the ordinary means, or when the smell appears to be due to some cause other than coal gas.

Unique Circumstances of Holborn Explosion.

While referring to the Holborn explosion, I should stress the unique circumstances of that unfortunate accident. The tube in which the explosion occurred was constructed of cast-iron pipes 9 ft. long of D-shaped section, 4 ft. 6 in. by 4 ft. 0 in., which had been laid for use as a pneumatic despatch tube many years ago. Access manholes had been provided at intervals, but these were all fitted with airtight covers. The section of tube in which the explosion occurred was roughly one half-mile in length. The total volume of this section of tube was approximately 37,000 c.ft., and its considerable length assisted, owing to the action of the explosion wave, in causing detonation which resulted in an explosion of exceptional violence.

It is doubtful if there is a similar tube in existence anywhere in the world; certainly there is none other in this country. The remaining sections of this tube have been ventilated and fitted with elaborate gas detection apparatus, so that there is no possibility of any similar occurrence in future.

It may be of interest to state that there has recently been a clear case of anaerobic fermentation in my Company's area of supply. An escape of gas into a cable box was reported at Pinner in June last. No leakage could be found on the mains and services in the vicinity, although searcher holes showed definite indications of gas when tested with a leakage indicator. A ditch had existed at the side of the road, but had been filled in, pipes being laid to convey the drainage. An analysis of the gas aspirated from the searcher holes showed that this consisted principally of methane and nitrogen, and was undoubtedly due to anaerobic formation.

Mr. H. Hollings (Gas Light and Coke Company): Soon after I heard Dr. Haldane's intention to read this paper, I learnt last June of the occurrence of an inflammable gas underneath a pavement in circumstances which indicated the probable presence of products of fermentation, and I made arrangements with Mr. R. J. H. Banks to take samples of this gas for complete analysis. The results of his analyses of four samples after deducting about 25% of air with which the samples were mixed are as follows:

Carbon dioxide	from	1·2%	to	2·9%
Unsaturated hydrocarbons	,,	1·6 ,,	,,	4·9 ,,
Carbon monoxide	,,	*Nil*	,,	1·5 ,,
Methane	,,	30·0 ,,	,,	48·6 ,,
Hydrogen	,,	*Nil*	,,	8·5 ,,
Nitrogen	,,	44·6 ,,	,,	55·5 ,,

No hydrogen sulphide or ammonia could be detected. The very low proportions of carbon monoxide and hydrogen make it highly improbable that this gas contained much, if any, coal gas. The low proportion of hydrogen and the absence of hydrogen sulphide made it unlikely that it was from bitumen covered electric cable. Excavation showed the presence of fermenting vegetation which appeared to have been deposited in the bed of an old ditch and to have been covered over with a pavement within

recent years. As an examination of the gas mains in the vicinity showed the absence of any leakage it appears that here is definite evidence of the occurrence of gas produced by fermentation underground in fairly considerable quantity. The samples with a proper proportion of air would be definitely explosive, and it is perhaps not unnatural that they were erroneously believed to contain coal gas.

Analyses of Scientific Importance.

Turning now to the evidence which we obtained concerning the production of gas by the fermentation of earth taken from the Holborn area to which Dr. Haldane refers, I have to report some analyses which I think are of considerable scientific interest. The gas to which I have referred above contains little hydrogen but a high proportion of methane. Indeed, methane is usually regarded as the normal product of the fermentation of sewage. Our work in connection with the Holborn earth, however, showed that by fermentation gas could be produced containing hydrogen rather than methane as the distinctive constituent. I will quote a few examples of the experiments we conducted.

541 grammes of one sample was fermented under anaerobic conditions at a temperature of 250° C. and after 66 hours 11·2 cc. of gas had been evolved. This gas contained 60·5% of hydrogen and 37·2% of nitrogen. Carbon monoxide and methane were absent. In another experiment with the same earth at room temperature 880 grammes gave 5 cc. of gas after 160 hours. This gas contained 45·1% hydrogen, 0·6% methane, and 48·7% nitrogen. From other samples of earth several other gas samples were obtained containing about 50% hydrogen and little or no methane. I have just examined a list of fourteen analyses which were conducted with great care by two experienced chemists, Mr. H. C. Exell and Mr. W. J. Gooderham, and the highest concentration of methane found was 8·6%.

In other experiments the organisms were fed with sterilized dextrose. This stimulated the production of gas, and concentrations of hydrogen up to 82% were obtained.

I think it is useful that this opportunity should have been provided of making these results known to the Industry if only because our work has shown the necessity for searching for hydrogen as well as methane in circumstances under which gas may be produced by anaerobic fermentation.

Is CO an Indication of Town Gas?

Mr. James W. Wood (Research Chemist): The paper presented to us by Dr. Haldane is of special value in giving authenticated instances of the presence of inflammable underground gases quite unconnected with the escape of gas from mains and services.

We are, however, upon occasion called upon to convince Medical Officers of Health and others that the suspected gas leak is not one of coal gas. The air-gas mixture is usually so dilute that it is not amenable to the ordinary methods of gas analysis. Further, unless the leak is considerable and samples are obtained quite close to the leak, the gas may undergo such changes by diffusion in the subsoil that identification by comparison with the normal town gas product is not conclusive. Dr. Haldane has shown how carbon dioxide, methane, and hydrogen may arise by anaerobic fermentation. That leaves carbon monoxide as the only characteristic constituent of town gas available for identification purposes; and I would like to ask Dr. Haldane whether, in the known absence of underground fires or the like, the presence of carbon monoxide alone would be sound evidence of coal gas leakage. The work done by Davis and Hartley, Masterman, and ourselves indicates the ease with which minute amounts of carbon monoxide can be determined when suitable precautions are taken. A few instances have come to my notice where leaks attributed to gas-works have been traced to the infiltration of gases, waste oil, &c., into porous ground around gas mains.

Comparisons of Biological Phenomena.

Dr. R. Lessing: Prof. Haldane has described his paper as "a popular account." I think the Institution must congratulate itself upon receiving a statement which popularizes the knowledge which Prof. Haldane has acquired over a lifetime in the examination of what, in this connection, might be termed the rarer gases, although he shows how frequently they appear. He has given us the opportunity of acclaiming him a past-master of the problems of the physiological effect of these gases, and of their occurrence, although we already knew him to be such. There is one great advantage in having this account, however sketchy Prof. Haldane might consider it to be; it gives us comparisons of the effect of these various biological phenomena in the type of gas which may be produced. The condition under which they are produced is perhaps not yet entirely known, but the statement now presented, by showing us the different occurrences and the different effects of black-damp, choke-damp, and other combustible gases such as methane, hydrogen, and so on, is of the greatest possible use.

Reference has been made by Prof. Haldane to the suffocation of men at Dagenham eighteen months ago, and with his permission I should like to give the analysis of a sample of gas taken there fifteen minutes earlier than the sample of which the analysis is given in the paper. As mentioned by Prof. Haldane, the samples were taken by one of my assistants, Mr. L. E. Winterbottom, and I think it well that his name should be mentioned, as he showed great resource in taking the samples in exceedingly difficult circumstances. They had to be taken as quickly as possible. The occurrence of the accident became known in London on a Saturday morning, at 11.30. The tackle had to be collected and conveyed by train to Dagenham, and for that reason it was 8.15 p.m. by the time the first sample was taken. The second sample was taken at 8.30 p.m., and the analysis of that is given in the paper by Prof. Haldane. The analysis of the 8.15 sample was:

	%
Oxygen	3·9
Carbon dioxide	9·1
Nitrogen	82·7
Methane	4·3

Carbon monoxide (estimated) could not have been more than 5 parts per 10,000.

Having these records (of which there are very few) we may be able, in years to come, to connect them with changes in the barometer, if that is possible.

I should like to refer to the influence of iron compounds on the formation of choke-damp. Prof. Haldane has referred to the absorption of oxygen by pyrites and coal. I should like to add to that, and I am sure he will agree with me that the effect of ferrous carbonates in coal is usually somewhat under-estimated or not taken account of. The carbonate of ferrous iron in coal, occurring particularly in the cleat and partings, is the most oxidizable of the inorganic constituents. Such iron compounds are also invariably present in the soil, and I suggest—and I should like Prof. Haldane's opinion on this—that these iron compounds (apart from the organic substances in the soil) may be responsible for the abstraction of oxygen from the air, and in that manner may be at least a contributory cause of the formation of choke-damp. If we have these iron compounds present in the soil, in a reduced condition—the muds with which we are dealing are frequently black—and if air passes through them, they will be prolific absorbers of oxygen. Also—though I hardly venture to throw this out as more than a suggestion—they may influence, catalytically or otherwise, the absorption of oxygen by the organic substances themselves.

Sulphuretted Hydrogen in Gasholders.

Mr. Gilbert B. Howarth (Chief Chemist, Newcastle-upon-Tyne and Gateshead Gas Company): The bacterial production of sulphuretted hydrogen in gasholders is of special interest to the gas-works man, since it provides a very plausible excuse in the unfortunate event of the Gas Examiner obtaining a dirty test paper! Could Prof. Haldane give us any idea of the quantity of sulphuretted hydrogen likely to be found in gasholder water?

Similar disturbances might be expected in station governors and in mains. I have in mind a case where minute stains were found on test papers exposed for many hours at the outlet of a station governor, while test papers at the inlet remained perfectly clean. These traces, far below the limits allowed by the Gas Referees, were found only when the flow of gas through the governor was extremely small. They might be due to bacterial action, but an alternative explanation is based on fluctuations in solubility in the condensate in the mains.

One of the difficulties of purification by means of iron oxide is the removal of the last traces of sulphuretted hydrogen. The persistence of these traces in the later boxes is often asssociated with a shortage of oxygen, and a small increase in the amount of added air is sometimes sufficient to clean up the section. Is it possible that these obstinate traces arise from some form of anaerobic fermentation in the oxide boxes?

Finally, I would ask Prof. Haldane if he is aware of any bacterial processes that lead to the absorption or destruction of sulphuretted hydrogen. A development in this direction might be of considerable value for supplementing the existing methods of gas purification.

An Opportune Paper.

Mr. C. S. Shapley (Leeds): A paper by so eminent an authority as Dr. Haldane on this very interesting and im-

portant subject is most opportune at the present moment, and the examination of the findings of the Commission on the Holborn explosion is very interesting reading.

It is an unfortunate fact that any persistent smell which may occur in the streets or houses, and about the origin of which there is any doubt, is immediately labelled coal gas; and the onus of disproving it to be coal gas is the responsibility of the local gas undertaking—a case of guilty until proved innocent!

The item showing the limitations as to how far the reading on a Short's indicator can be accepted as evidence of coal gas and not an accumulation of anaerobic gas is very useful. Another interesting point is the effect of barometric pressure on the liberation of underground gases; and this information may provide a clue to some of our unsolved problems where smells of coal gas have been reported in cellars and similar places, but on examination no apparent gas leakage could be found to account for it.

Prof. Haldane mentioned that with the surface soil well aerated, both small coal gas leaks and anaerobic gases are readily consumed by the micro-organisms in the soil so that aeration of the subsoil of our thoroughfares would appear to be essential for safety against the accumulation of these gases, and should be part of any scheme of roadmaking where impervious layers of concrete or similar material are used.

We in Leeds now make a practice of placing ventilators in the road above our gas mains, which fulfil the functions of ventilating the subsoil and also provide immediate warning should a leak develop in the gas main.

The paper has been very topical and instructive, and I would like to thank Dr. Haldane for the interesting manner in which he has presented his subject.

Professor Haldane's Reply.

Prof. Haldane, replying, said: This discussion has been of very great interest to me. The new facts brought forward are very important. The first point I will deal with is whether the presence of carbon monoxide is characteristic of a coal gas escape, and particularly, whether a very small trace of carbon monoxide on the surface gives presumptive evidence of an escape of coal gas. Certainly a considerable quantity does, but when we come to testing with iodine pentoxide, and so on, I think the matter is rather different. I would remind you of one fact which is mentioned casually in the paper, that ordinary coal, if enclosed in a bottle, will absorb all the oxygen, and it will form very little carbon dioxide; but if you examine it carefully, and if your gas analysis apparatus is not swamped by methane—it is better to use coal which has lost all its methane—you will find a very distinct quantity of carbon monoxide there. Carbon monoxide is formed during the oxidation of coal at ordinary room temperatures, and it is formed in very appreciable quantities. When you have coal in a confined space you will probably get 0·2% of carbon monoxide in the residual gas. I discovered this fact over thirty years ago, and it was a great surprise; I should never have discovered it had I not possessed a very accurate gas analysis apparatus. I confirmed it by means of the blood test—I am never satisfied with regard to carbon monoxide without applying a blood test, or an equally positive test. But that formation of carbon monoxide is not peculiar to coal. I have experienced it in connection with accidents in ships' compartments, where a space has remained unventilated for some time, all the oxygen has disappeared, and carbon monoxide may be found there. If you oil some cotton waste in boiled linseed oil—the linseed oil used for making paint—and enclose the oiled cotton waste in a flask, the oxygen will disappear; the oil oxidizes rapidly, and you will find about 0·2% of carbon monoxide in the residual air. I do not know how many oxidations give a little carbon monoxide, but I am never surprised when a little turns up. I found it a few days ago in the gas present in silos. I was rather interested to see what gases there were inside a silo, or inside a haystack (which latter is another case). There you will find rather an interesting variety of gases, but there were traces of carbon monoxide, formed from the air, apparently, by simple oxidation. But I am afraid that in that case I have only determined the carbon monoxide by the iodine pentoxide method, and have not yet confirmed it with the blood test or any other test. So that it is just possible that there might be some mistake. Traces of carbon monoxide turned up—Mr. Hollings found some—underneath the tube at Holborn, but they were mere traces, as determined by the iodine pentoxide method. I was not at all sure where they had come from; I think they were due to oxidation occurring in the soil. At any rate, I should not be prepared to attribute them to escapes of coal gas. I do not think that a delicate test for carbon monoxide is necessarily a conclusive test of the presence of coal gas. As the question was raised in the discussion, I wanted to give my own experience on the subject, but it is a subject on which one must use caution. If there is a good deal of carbon monoxide, that is a different thing, and you can be pretty sure that there is coal gas about.

Explosive Marsh Gas.

Both Mr. Lacey and Mr. Hollings mentioned a case in which marsh gas (*i.e.*, methane) was found in explosive proportions, formed, apparently, underneath a roadway. I believe it was in a country district.

Mr. Lacey: It was in Pinner.

Prof. Haldane: That is in the country?

Mr. Lacey: Yes, or in the suburbs.

Prof. Haldane: It is a very interesting case; there was hardly any hydrogen. Do you think there was any hydrogen at all, Mr. Hollings?

Mr. Hollings: There were small quantities.

Prof. Haldane: Were they real quantities, or had they anything to do with the gas analysis apparatus?

Mr. Hollings intimated that the apparatus was not at fault.

Prof. Haldane: I asked because nearly always when I have come across such formations they have consisted either of pure hydrogen or pure methane; but, of course, gases might come from different places. Curiously enough, I was talking, during lunch, to my neighbour, Sir John Russell, on this subject of the formation of hydrogen. He knew that hydrogen, as well as methane, was formed in the decomposition of cellulose, and he told me—he confirmed what I believed before—that much of the formation depends on the reaction. Then he suggested that the soil underneath London is on the acid side. That may be the reason why we got hydrogen, and not methane, there. It is a very interesting point, which I hope will be investigated. Hydrogen is a nastier gas, so far as explosions are concerned, than methane, and the fact that it is formed sometimes in large quantities is very remarkable. We get hydrogen in silos, though not very much, but not a trace of methane, so far as my own experience goes. But that, again, may depend on the reaction. You have an alkaline reaction with the methane. These reactions given by Mr. Hollings are very interesting, and I am glad they are to be published in the "Transactions" in full, because I think they will often be quoted in future.

The sample of the gas in the caisson at Dagenham, taken earlier than the sample of which the analysis is given in the paper, was not so pure as the later one. I think a little air must have got in, because there was 3½% of oxygen in the earlier sample, whereas there was practically no oxygen in the later one. If you allow that the oxygen was due to air leakage into the sample, however, the percentage of methane was rather higher than was the case in the later sample, as though the methane percentage were going down. There is not much difference, but the difference is on that side, if you allow for the air which leaked in.

Then Dr. Lessing raised the question of carbonates of iron and sulphides, and asked whether I think that the carbonates have much to do with the formation of black-damp. The ferrous carbonate will absorb some oxygen, but it does not deliver the goods in the way of gas of the composition that black-damp usually has.

Dr. Lessing: I referred to choke-damp, not black-damp.

Prof. Haldane: Well, they are only names; some people call it choke-damp, and some call it black-damp. But there was certainly a case at Balcombe, in a well 120 ft. deep, where the gas was coming out at the bottom and overflowing at the top. The water pumped up had a lot of ferrous carbonate in it, which was precipitated. They had to aerate it to get rid of it, but I do not think the presence of the carbonate itself would account for the gas. I think there must have been sulphates there to give the composition of gas observed. I think you will find difficulty in producing a proper equation for that formation with carbonates alone.

Dr. Lessing: I thought of the absorption of oxygen merely as a contributory cause of the formation of the other gas.

Prof. Haldane: I think that in the case of the well at Balcombe the iron carbonate must have been contributing to the disappearance of oxygen, but I do not think it would account for the composition of the gas.

Dr. Lessing: If the iron carbonate was in the water, it would be present as bicarbonate, and then you would account for the carbon dioxide on oxidation.

Prof. Haldane: Well, perhaps you would. I thought there was some difficulty in doing it, but it is a matter of putting the equations on paper and working them out. There is no doubt that there was ferrous carbonate in the water, and if you can square that with the composition of black-damp, well and good.

A question was asked concerning the quantity of sulphuretted hydrogen there may be in the water from gasholders. I do not know; but you can get an awful lot.

Once I met with sulphuretted hydrogen in a coal mine, and obtained a sample of the organism which was doing it. It occurred in some old workings; the water was flowing out, and I got a sample, which I put into a bottle, and stoppered. It had a dreadful smell of sulphuretted hydrogen. I fed it with calcium sulphate and kept it for a year on the mantel-piece at home. Every time the stopper was loosened it went off with a puff, and there was an awful smell. Then the housemaid happened to take out the stopper, and, after smelling the contents, threw the bottle away, and I saw no more of it.

I am afraid I cannot offer any opinion on the problem raised by Mr. Howarth as to getting rid of the last traces of sulphuretted hydrogen from the oxide boxes by adding air. I cannot remember the data on the subject of the organisms destroying sulphuretted hydrogen, but possibly Dr. Lessing does. My impression is that they eat it up quite peaceably, provided there is oxygen there, as they eat up hydrogen and even carbon monoxide. I am very interested in what was mentioned on behalf of Mr. Shapley as to the ventilation of gas mains at Leeds and other places.

2nd Report of the Liquor Effluents and Ammonia Sub-Committee

Research Chemist: A. Key, Ph.D., B.Sc. *Research Assistant:* W. Etheridge, B.Sc. *Temporary Research Assistant:* A. H. Eastwood, Ph.D.

Mr. Alfred L. Holton (Chief Engineer, Manchester Corporation Gas Department): The report as a whole appears to be mainly a résumé of past work. The appendices contain further details of work done on the general subject of the treatment of ammoniacal liquor or effluent, but practically very little new light is thrown on the question.

Tricresyl Phosphate as Solvent.

With regard to tricresyl-phosphate as a solvent, it is noted that " there is reason to fear that the solvent would deteriorate with continued use "—a possibility to which I called attention last year. Appendix 4 (*a*) on the use of tricresyl-phosphate as a solvent appears to dispose of the subject as a practical issue. This solvent evidently removes more of the higher tar acids than does benzole, but the separation of the liquor for the manufacture of ammonium chloride as at Partington has the ultimate effect of reducing the higher tar acids in the effluent.

Tar Oils as Solvent.

It has long been known that the basic bodies in tar oils are to a large degree the cause of the high solvent capacity of such oils for phenols. It is of interest that the tar oils are found to remove more higher tar acids than does benzole.

In regard to the recovery of the tar acids (tar oil extraction) by distillation, provided that an oil of high boiling point is used, distillation might give effective separation under certain conditions, but would not the oil gradually become vitiated by the residue of pitchy matter, or lose the bases on distillation? The remarks on the loss of the bases in the tar oil are of great importance. It might be more satisfactory to extract the tar acids by caustic soda, but the question of cost would need serious consideration.

Bacterial Oxidation.

The information given in this respect is interesting, and confirms the findings of Dr. Fowler. It is noteworthy that the report emphasizes the " necessity of making an extended test with both spent and ammoniacal liquors before coming to any conclusion as to whether they can be dealt with successfully or not." No figures of costs are given in the present report, but the cost of bacterial purification would certainly be prohibitive at Partington. Taking a cost of 1d. per 1000 gallons of general town effluent treated at the sewage works, it is reasonable to assume that since the O/A figure of gas-works effluent is 50 to 100 times greater, the cost will rise in proportion. This confirms Dr. Fowler's contention that the proper place for the total or partial treatment of liquor effluent is the gas-works. The report states that gas-works ammoniacal liquor is much more toxic to sewage bacteria than spent liquor—a serious matter when the manufacture of sulphate of ammonia is suspended.

In regard to the determination of benzole in gas-works liquor, the method given by Dr. Key appears sound; and we are now comparing it with the simpler method which has been in use at Partington.

Mr. F. R. O'Shaughnessy: Dr. Key has been good enough to include a brief précis of my further investigation of the effect of ammoniacal gas liquor on the treatment of Cheltenham sewage. That investigation showed that by gradually increasing the dose of ammoniacal liquor, 0·5% by volume of this liquor in the sewage can be dealt with in the oxidation plant and quite good effluents can still be turned out. There is evidence that the capacity of the oxidation plant for assimilating ammonia from this mixture of sewage and ammoniacal liquor was reached. Experience shows that it is unwise to draw conclusions hastily in these matters. At my suggestion the Cheltenham Corporation and the Cheltenham Gas Company agreed that the sewage purification plant should be kept under observation by me for several years, during which time the whole of the ammoniacal liquor produced at the Gas Company's Works should be passed under control to the public sewers. The living organisms have marvellous powers to accommodate themselves.

I pointed out at your last annual meeting that it was not justifiable to generalize from results such as those obtained at Cheltenham, because of variations in the character of the waste gas liquor, the sewage, the form of sewage plant, &c., at different localities, and I am glad to note that Dr. Key draws attention to this in his report. During the past year the importance of these points has been well illustrated at several places where I have been called upon to advise; and in one case it was necessary to limit the discharge of waste liquor at the gas department to 0·1% by volume of the sewage, because of the presence in the sewage of another trade waste with high oxygen demand. This coincides with the finding at Hinckley.

I am glad also that Dr. Key emphasizes the limitations of the " oxygen absorption " from permanganate test in assessing the effect of waste liquor from gas-works on a sewage treatment plant. For some years I have drawn attention to this fact, pointing out the need for some more satisfactory basis upon which to form a judgment. In this respect Dr. Key's work on the relative ease with which phenols, higher phenols, thiosulphate, and thiocyanate can be dealt with by biological oxidation is to be highly commended.

It must be pointed out, too, that the rôle of ammonia in the biochemical oxidation is an important one, for it may be helpful or harmful, according to circumstances. Also, it may be well to draw attention to the fact—which is not generally appreciated—that all the ammonia in the liquor to be oxidized does not necessarily share the same fate. Some may be converted to nitrate, some will go to build up protein, or living matter, in the oxidation plant, and some may actually escape to atmosphere as gaseous nitrogen.

Another point which is of great interest to me personally, as it confirms a general principle of considerable practical importance observed by me, is that anaerobic fermentation is more sensitive to antiseptic bodies than aerobic fermentation. It will be of interest to Dr. Key to know that the recognition of this important principle has not so far appeared in the general literature dealing with sewage disposal. I have utilized the principle in large-scale operations for inhibiting offensive odours on sewage works.

Dr. Key's report brings out very strongly the fact—which I have insisted on for some time—that in general the most economical method of disposal of the waste liquors from gas-works is their adequate dilution and proper handling at the sewage disposal works.

Dr. Key refers to the discrepancy between the oxygen absorption by permanganate results and those from the biochemical oxygen demand tests in the Hinckley effluent in October, when ammoniacal liquor was present in the sewage. This phenomenon was investigated by the (Iddesleigh) Royal Commission on Sewage Disposal, and indicates

incomplete destruction of fermentable material in the effluent.

Finally I would point out that the trend of events seems to indicate that your Liquor Effluents and Ammonia Sub-Committee and those responsible for sewage disposal are coming to a certain amount of common ground; it gives me great pleasure to be one of those who have the privilege to co-operate with your Committee in this common problem. I would particularly commend the clear vision and careful work of Dr. Key, as exemplified in this report, and wish to express appreciation of the lucidity with which he has set out his findings.

Dr. A. C. MONKHOUSE: I should like to express my appreciation of the opportunity you have given me of attending this Research Meeting. I cannot let this occasion pass without referring to the death of Mr. Lee, of Hinckley. He was of great assistance to me personally in the early days of the Research; his enthusiasm for the work, combined with his wide practical knowledge, was invaluable. He was a man who endeared himself to all with whom he came in contact; and I wish to place on record my humble tribute.

This 2nd Report of the Committee deals in detail with the oxidation of ammonia liquor by bacterial treatment. Reference is made to the greater difficulty of treatment of the crude liquor at the Hinckley than at the Cheltenham Sewage Works, due partly to the abnormally high thiocyanate content of the Hinckley liquor and also the high volume of sterile trade waste to be treated. In numbers of cases this method of treatment at the sewage works has been found mutually satisfactory. There is, however, the question of the point of discharge of the ammonia liquor into the sewers. Perhaps an average figure for the volume of ammoniacal liquor to the dry weather flow of sewage would be 0·3% for a similar area, but this is the dilution figure for the *whole* of the sewage. There are cases where the ammoniacal liquor discharge does not take place into a " trunk " sewer but into a subsidiary one. If the flow of sewage is small, the concentration of ammoniacal liquor in that particular sewer may be high; and if also, as is sometimes the case with antiquated sewer systems, the drains are untrapped, there is the danger of the fumes of ammonia liquor getting back into the houses. This, of course, can be avoided by ensuring that the point of entry is into a sewer where there is considerable dilution and that the sewer and its connections are sound.

With regard to the influence of ammoniacal liquor on the purification of sewage at sewage disposal works, I should like to ask Dr. Key if he has any information as to the effect it has, if any, on the preliminary settlement of solids in the sedimentation or precipitation tanks.

In the detailed figures for the treatment of ammoniacal liquor at the Hinckley Sewage Works, I am not quite clear why there is an increase in the suspended solids from 4·9 in the town tank to 8·1 in the feed to the beds. Does it mean that the Sketchley effluent, in which the solids are *nil*, caused a precipitation of solids? In the previous period of July the difference in the figures—4·0 and 4·6—is less.

I notice in the remarks on the isolation of " Strain O1 " as the phenol destroying bacteria that the organism can grow in a solution containing no other source of organic carbon than phenol. Does that mean for an indefinite period? It has always been the impression previously that other sources of organic carbon, such as sewage, were necessary to prolong their growth indefinitely. How does the " Strain O1 " compare with that isolated by Fowler and Ardern in their researches?

The use of tar oil as a solvent in the place of benzole is one which has an appeal, as presumably it is less costly than benzole. One of its specifications is that it should boil at a higher temperature than phenol to allow of the recovery of the latter by distillation. Will not this mean that the polyhydric phenols are left in the oil? Is the method of removal by soda solution considered to be impracticable because of the formation of emulsions? There was a plant working in Germany in 1929 in which tar oil was used as a solvent and the phenols recovered by washing with soda solution. I believe that some trouble had been experienced from emulsions.

I should like to congratulate the authors on a very real increase in our knowledge on a much maligned but very necessary problem.

Mr. D. C. CROSS (Lea Bridge): I wish to deal only with one section of the report, concerning the problem of concentrated liquor. I have had some small experience of concentrated liquor, and Mr. Botley has asked me to give it at this meeting. But I should like first to pay a tribute to Mr. Parrish, for all the credit for putting in the concentrated liquor plant is due to him, and all the details have been worked out by him.

At Lea Bridge we were up against a very difficult problem concerning the effluent. All the effluent passes into a tributary of the Lea. Ten years ago the Lea Conservancy barred all effluent that had any colour, odour, or sediment; it had to be perfectly clear. You can appreciate that it is almost impossible to obtain an effluent practically like clear water from a gas-works, especially with the effluent from water gas plant, but we attained the required standard and have been able to maintain it for ten years. In consequence of the ban on colour, however, we had to stop the sulphate plant ten years ago, and we have had to dispose of the liquor elsewhere; it had to go to manufacturers, for making up into sulphate of ammonia. The cost of carriage of the liquor has been increasing gradually, and now, with the price of sulphate down to £5 5s., the cost of disposing of the liquor is approaching the region of 8s. or 9s. per ton, which is prohibitive.

The cost incurred by the Company last year in getting rid of liquor only was £1500, and this year it would have been well over £2000 unless steps were taken to prevent that increase. Therefore, we installed the concentrated liquor plant, at a total cost of about £800 (including accessories), and we are now concentrating up to 15% ammonia, which is equal to 70-oz. strength. We have tried to concentrate up to 17%, and in fact have exceeded that, but during this colder weather it rather condenses out and solidifies. The 17% concentration is equal to 80-oz. strength, but during the cold weather it is hardly possible to concentrate to that extent unless special heating precautions are taken, to prevent solidification. But with the present concentration of between 15 and 16 p.ct., for every 10 tons of crude liquor we are getting 1 ton of concentrated liquor. The cost of concentrating is about 1s. per ton of crude liquor, or 10s. per ton. of concentrated liquor. Of course, the cost to a gas-works is dependent largely on the cost of the carriage in disposing of the concentrated liquor. We are working to a schedule whereby, if the cost of sulphate were to rise to £7 or £8, the cost to us would be something like 1s. 10d. per ton on the crude liquor, but with the price of sulphate in the region of £5 5s., the cost to us is between 3s. 6d. and 4s. per ton on the crude liquor. Thus the figure is still high, but we have practically halved the cost which we incurred when disposing of the liquor in the crude form.

With regard to the disposal of our effluent liquor, we are now able to discharge it into the sewer. The Leyton Borough sewer has been taken over by the L.C.C., and we have made arrangements to put the effluent liquor into the sewer provided we maintain a certain standard, and the effluent contains only 0·01% of free ammonia or 2-oz. strength of fixed ammonia.

The steam consumption has been about 20 or 21% of the weight of liquor put into the plant, so that for every ton of concentrated liquor made we use about 4600 lbs. of steam.

Dr. F. C. HAPPOLD: Two points have been raised in the discussion on which I should like to make some observations. First, perhaps I might answer more readily than Dr. Key the question raised by Dr. Monkhouse as to the relationship of our " Strain O1 " to the organism which was isolated by Fowler and Ardern—the strain B. Helvolis. There is no relationship. The B. Helvolis has an optimum temperature of growth of about 22° C. The " Strain O1 " shows quite marked metabolic activities capable of breaking down phenols over quite wide ranges of temperature, but it appears to have an optimum temperature of growth of about 37° C. I think B. Helvolis is usually understood to be an organism found normally in water supplies far from sewage contamination, whereas the strain we have is definitely largely restricted to sewage contamination. Perhaps I ought to mention that this particular piece of work, in its inception, was due largely to Dr. Monkhouse himself.

The second point I should like to make is that I concur in what Mr. O'Shaughnessy said when he mentioned other possible sources whereby the ammonia figure might be brought down. At the end of Appendix 1 (*a*) of the report there is a comment that it is rather remarkable that bacteria can deal with up to 0·3 p.ct. of free ammonia. I think I ought to say that further study of the " Strain O1 " is tending to show, as I rather expected, that the whole question is probably one of reaction. There is no particular toxicity, I think, for the strain, as ammonia *per se;* I think it is a question of the reaction of the media. It is interesting to note that you cannot start a culture of this organism growing from the beginning in this synthetic medium at a reaction of *p*H 8·5; it is necessary to bring down the reaction lower for the culture to grow.

Dr. G. W. ANDERSON: It seems to me that stress must be laid on the Committee's recommendations not to destroy liquor, but to retain a share of the market in ammonia. That leads me further, to the submission that Mr. Holton's contribution to this particular subject should be made public as quickly as possible. I have looked in vain for this particular information in the Committee's report.

The whole question of effluents resolves itself into the disposal of spent liquor, either after treatment, such as Mr.

Holton applies to it in Manchester, or without treatment, depending entirely on the nature of the effluent and the local circumstances. On those premises one may say, then, that the manufacture of some ammonium products should be maintained. For many years I have been interested in the recovery of bye-products, and I have been associated to a certain extent with Mr. Parrish, who is a past-master in the design of chemical plant for this particular purpose. I am not surprised that Mr. Cross has obtained such wonderful results, and Mr. Parrish and I agree, I think, that for smaller works the concentration of liquor is a good thing. Mr. Cross has experienced difficulties due to the solidification of the ammonium carbonate in his liquor; but if he went to a strength of 25%—which necessitates the use of a dissociation still prior to the main still—he would secure freedom from that trouble, and, incidentally, obtain a more highly concentrated liquor which could be worked up at the chemical works in a centralized plant. Centralization and rationalization of the ammonia industry has been advocated in many quarters, and negotiations are on foot for the concentration of the manufacture of ammonium products—sulphate of ammonia and others—but I do not know how far those schemes have materialized.

I do feel that a good deal more could be done in reducing process costs if rationalization and centralization were to take place. It is a well-known fact that ammonia stills can be built which will produce, at a minimum, 50 tons of sulphate of ammonia; a very large organization in the chemical industry of this country has stills which are as big as scrubbers, and controlled by the same staff. Therefore that organization is in a position to produce ammonia products much more cheaply than the Gas Industry can produce them in small units. I would urge that some help be given by the Committee to the Gas Industry, and particularly the smaller understakings, by advising them to adopt some scheme which would enable them to retain some share of the ammonium market, either directly or indirectly.

The PRESIDENT: We are very much indebted to Mr. Botley and his Committee, to Dr. Key, and the other gentlemen who have assisted in this work. I should also like to thank Mr. Holton for his contribution to the discussion. The loss of revenue in respect of sulphate of ammonia manufacture is a matter of very great concern to some of us, and if the Committee and Dr. Key can show us how to make a profit we shall be very pleased indeed.

Mr. BOTLEY: I should like to refer to one or two practical points before Dr. Key replies to the discussion. I must remind the meeting that this question of the method of disposal of liquor or effluent depends largely on the size of a works. What can be done at Partington cannot be carried out in many smaller works, where the difficulties are also acute. The transport question always crops up, whether we are dealing with crude or concentrated liquor; and we must have some means for the disposal of crude liquor or spent liquor, as the case may be, in cases of difficulty. The sewers offer possibilities for that. We have never pretended that we could deal with liquor at the same cost as that of dealing with ordinary sewage, but we do expect to have facilities for our trade effluent in any town where we are large ratepayers. It is only right that we should recognize wherever possible—and in many cases we are very pleased to recognize—that there is some additional cost. Obviously, the liquor can be dealt with more economically and better at the sewage works than at a special plant in a small gas-works, where the cost of purifying liquor would be out of all proportion. It is in such cases that we have to secure the help of Mr. O'Shaughnessy and others, and to-day we can dispose of, and are disposing of, liquor to sewage works with the greatest possible facility where conditions are suitable, and even where the activated sludge system is used.

I am very much obliged to Dr. Monkhouse for his reference to our late friend, Mr. Lee, of Hinckley. His death was mentioned in the report.

Dr. KEY: In regard to the method of estimating dissolved benzole in liquor, I should be very pleased to give Mr. Holton any further particulars if it is not described in sufficient detail in the report.

I should like to thank Mr. O'Shaughnessy for his useful contribution, upon which I have no comments to make, except that I am in entire agreement with him. He made some very kind remarks with regard to myself; indeed, he was almost too kind to me, and I should like you to remember, when reading his contribution, to substitute "The Liquor Effluents and Ammonia Sub-Committee" where he mentions my name. The Committee is responsible for the work.

The points raised by Dr. Monkhouse are pertinent. The question as to the point of discharge is most important, and it is not emphasized in the report, though perhaps it should have been. I think it is mentioned that at Hinckley we selected a sewer from which there was very considerable flow, both in the day and in the night; and I would point out that that is always necessary. It is not even sufficient that there should be a plentiful flow of sewage through the sewer during the day-time; there must be a flow during the night as well, unless, of course, the flow of liquor is cut off during the night. We have carried out preliminary experiments on the influence of gas liquors of various kinds on the process of settling of ordinary sewage, but I am afraid I can give no information yet, as our results have not been confirmed. I cannot explain why the suspended solids in the feed to the beds in our Hinckley experiments were greater when our liquor was being treated than previously. I am not at all convinced that it is due to liquor alone. A possible explanation is that the amount of sewage treated at that time was considerably in excess of the amount being treated on the previous occasion, and that the time of retention in the tanks (to allow for settlement) was very much reduced on the later occasion.

As to whether or not the "Strain O1" can live for ever without any other source of organic carbon than phenol, we have not been working on that "for ever," but, as far as we can tell, it does. It may need some other carbon, but no other organic carbon; there are carbonates in the solution, but no other organic carbon.

Report on the Conversion of the Potential Energy of Coal Gas into Radiant Energy

Dr. HAROLD HARTLEY, Chief Chemist, Radiation, Ltd.

The CHAIRMAN (Mr. J. H. Canning): I am sure we have all listened with very great interest to this most valuable communication from Dr. Hartley, and I should like to thank him on behalf of all of us for putting this subject before the meeting to-day. This is a communication of very great interest dealing with a subject intimately connected with our everyday practice.

Prof. W. A. BONE: Knowing what I do of Dr. Hartley's scientific attainments, and the rare combination of experimental skill, patience, enthusiasm, and thoroughness which he always brings to bear upon his researches, I feel sure that all present will realize how greatly the Gas Industry is indebted to him for thus laying open the results of his almost unrivalled experience in the analysis and measurement of radiation from gas fires. Long years ago, when I had the privilege of his collaboration in research at the University of Leeds, what most impressed me was his power of getting down to the fundamentals of a subject and his selfless devotion to research for its own sake. And had he chosen a career in academic research for himself, undoubtedly he would have achieved distinction and in due course have become a mere Professor, which is a dog's life, being nothing but "one damn thing after another." But a kindly Fate willed otherwise when it diverted him into gas-fire research, and what the academic world has lost your Industry has gained, much to its advantage. His present report is, if I may say so, entirely characteristic of all his work. For while never losing sight of the practical issues necessarily paramount in an investigation of the kind in a technical research laboratory, he maintains it at a high scientific level throughout, always keeping fundamentals in the foreground; and I venture to think that his report will long serve as a model of how such work should be carried out and expounded. And both the Industry and his firm are to be congratulated upon his presentation here to-day.

Its subject matter is of great fascination and intricacy, and although still somewhat speculative, it has been much clarified by modern conceptions regarding both the constitution of atoms and molecules with their electronic orbits, and the conditions determining chemical change in gaseous media. And perhaps the most useful contribution that I can make to its discussion is by way of amplification of his thesis.

In normal circumstances there is, at any given temperature, a certain equilibrium-distribution of the total

energy of a gas between (i.) *translational* or *kinetic* (*k*), due to external movements of the molecules as a whole, causing temperature and pressure, (ii.) *rotational* (*r*) or movements within each molecule caused by collisions with others, and producing no external physical effect, and (iii.) *vibrational* (*v*), partly due to vibratory movements affecting the atoms themselves and partly also to electronic displacements within them, all of which are primarily connected with the absorption and emission of radiation. And I think it is now generally agreed that any luminosity in a gaseous medium originates in electronic displacements and that the radiations emitted by vibrating atoms are confined to the infra-red region.

When a neutral gas is heated, in absence of chemical change its temperature may be raised to a fairly high degree before any self-luminosity becomes discernible; it may be doubted, for example, whether anything but the faintest sign of incipient luminosity would appear at such temperatures as those of a bunsen flame or, say, about 2000° C.; at still higher temperatures, however, self-luminosity would soon become discernible, and at the temperature of the electric arc it would be very marked. It should, however, be understood that any luminosity in a gas, however produced, implies considerable electronic displacements even to the complete expulsion of electrons.

When a medium containing combustible gas and air is raised to a temperature just above its ignition point, it inflames, and the resulting chemical changes are of such violence as to cause not only a large increase in the kinetic energy, but also big electronic displacements with consequent emission of high frequency radiation in the visible and ultra-violet of the spectrum. Indeed at the moment of combustion the normal equilibrium between the three types of energy is violently disturbed, and some time must elapse before the energy distribution is again in equilibrium with the environment.

Although it used to be thought that exchange of energy between matter and the ether is continuous, it is now universally agreed that it takes place by discontinuity in multiples of a small energy unit called the quantum, so that the emission of radiation from a burning medium is essentially " atomic " in character. The quantum, ϵ, however, is not a fixed quantity of energy, but a function of the frequency, v, and a natural constant, " h " ($= 6{\cdot}5 \times 10^{-27}$ ergs), such that:

$$\epsilon = hv.$$

The vibrating entities producing visible and ultra-violet radiation are probably the electrons; while radiation emitted by vibrating atoms is probably confined to the infra-red region.

Speaking generally, before a chemical change such as those concerned in combustion can take place, the molecules involved must first of all be " activated " to some degree by absorption of radiation; in case of slow reactions, an " induction period " is often manifest, and sometimes it can be detected even in explosive reaction.

When an explosive gaseous medium is ignited, a very sudden and violent change occurs whereby new molecules are born in an intensely vibratory condition, involving violent disturbances and re-arrangements of electronic orbits, extending to expulsions of electrons and giving rise to the quantum-wise emission of ultra-violet and visible radiation of high frequency, the quanta of which are large compared with those of the infra-red. Most of these are forthwith rapidly degraded as the result of many successive *per saltum* absorptions by other molecules and re-emissions therefrom of radiation of progressively lower frequencies, until eventually they appear as infra-red emissions. And at every such successive absorption and re-emission, involving as it does a diminution of the quantum-energy, the difference between absorbed and emitted radiant energy is transformed into kinetic energy producing temperature. Only a minority of the high frequency energy originally emitted during the chemical change escapes such degradation and appears as such outside the medium. Hence it is, as Dr. Hartley has said, that the *resultant* radiation eventually emitted by a flame is mainly infra-red and only a small fraction of it visible or ultra-violet.

Such, at any rate, is the view I have come to largely as the outcome of my researches upon gaseous combustion at high pressures during the past dozen years. And I think that the former view long maintained by Paschen that the radiation from flames is purely thermal in origin must now be abandoned in favour of a chemical origin.

So long as it is borne in mind that Dr. Hartley's analyses and measurements of the radiation from coal-gas flames refer only to the *resultant* radiation, I have little or nothing to say in criticism, for they have been carried out with exemplary skill and exactitude, and as such are of the greatest interest and value. And what he has said about the effects of inserting various solid bodies into such flames may be commended to the close attention and consideration of all makers and users of gas fires. The question of how far they induce catalytic combustion, upon which he has touched, probably depends on the oxygen content of the gaseous medium in their immediate vicinity; because, whenever and in so far as the gaseous layers immediately in contact with a red hot surface contain both combustible gas and oxygen, catalytic combustion must, it seems to me, be powerfully induced. Moreover, there are (I think) grounds for believing that an incandescent surface not only accelerates combustion in gaseous layers in contact with it, but also the subsequent attainment of normal energy-equilibrium of the products, including their electrical neutrality (*i.e.*, de-ionization).

The seven spectral curves reproduced in the paper are of outstanding interest, showing, as they do, the possibilities of controlling the infra-red radiation from the radiants of gas fires.

My only two criticisms are on quite minor points—namely, that the use of the expression " a stationary explosion wave " as applied to a bunsen flame is misleading, and should be replaced by some such phrase as " stationary flame front; " and that what Prof. W. T. David showed in regard to the influence of pressure upon the radiant energy emitted from explosions was that it caused a *relative* but not an *absolute* diminution therein.

Early Days.

Dr. E. W. Smith: There are probably two justifications why I should have something to say this morning. One is that I was associated with Prof. Bone and Dr. Hartley in the early days of the very crude experiments that were carried out on gas fires about twenty-two years ago and we then developed methods of testing, initiated and originated, I believe, by the Committee in conjunction with Dr. Drugman, which have formed the basis of the present methods of testing gas fires. The other justification is that the Institution has brought into being during the last few weeks a Committee known as the Gas Appliances Committee which has on it nothing but specialists, those who are intimately engaged in carrying out the technical operations and who are collaborating with the manufacturers and their chemists, and the chemists of the larger gas undertakings in order to arrive at an acceptable and agreed method for testing gas fires. I should like to associate myself very warmly with all that Prof. Bone has said with regard to Dr. Hartley's paper and the experience, knowledge, and ability that lies behind it. Dr. Hartley has been concentrating on this class of work for the last 22 or 23 years, and it is a privilege that the Industry should have at its disposal the concentrated experience of that long period because, when you think about it, the value of this paper is primarily to competitors, in placing before everyone the theories of the fundamental considerations behind the development of gaseous heating, is a gesture on the part of Dr. Hartley and his companies which is of very great importance, and is almost epoch marking in the annals of the Industry.

Of course, when work was done originally in this connection, we had, as most of the University research has, to show quick results, and there is always the fight between spending a great deal of time on fundamentals and demonstrating to the Industry, particularly in the early days, the necessity of the work by showing quick results, and I remember in connection with this early work that after a certain amount had been done with the very closest co-operation of the gas fire manufacturers—after the first year—those who were experimenting and were getting these results were asked by the gas fire makers to come round and discuss with their technicians the implications of the work that had been done. As a result we indicated the importance of the shape and the composition of the fuels, the position of the fuel as regards burner and the position as regards the back brick, the importance of insulation—*i.e.*, the conductivity of the back brick—and other considerations. Dr. Hartley and other makers of gas fires are beginning to understand these factors which influence the results that can be obtained from gas fires. There is no more important subject to-day, I suggest, than this work on gas fires. The competition that we have with the electrical industry necessitates that not only shall gas heating from gas fires be efficient but that the fires shall have a good appearance and shall be as convenient, or as nearly convenient as possible, as competitive articles. This subject is one which bristles with difficulties. You can imagine what would happen if some gas undertaking had a brilliant idea and brought out a completely new gas fire, a new type of gas fire, something that was fundamentally different from anything that had ever been originated before. The result of that would be that practically all the gas fires in the country would be a back number and the result would be that practically all gas fires would go up in

price and there would be the complaint that the user of gas fires was being exploited. What we want, therefore, to my mind, is a continuation of this work of the type that Dr. Hartley is doing. Let this work be continued and let there be collaboration between the various makers and with the gas undertakings. Let that go on as much as possible so that the development is on evolutionary lines without sudden changes, because by means of sudden changes you will get high costs which will definitely act as a deterrent to the development of the use of gas and to the development of the Gas Industry.

I think this work of Dr. Hartley has two primary significances. One is that this collaboration between the makers of gas appliances and the Gas Industry should be extended, and the other is that the work which Dr. Hartley is doing is fundamental without which, whether it is done by manufacturers or the Leeds University or the chemists in the Gas Industry, we shall not make the progress that is essential.

The Thermal Side.

Dr. Margaret Fishenden: I do not think I really have very much to say about this paper except that I have read it with great interest, and, if Dr. Hartley will forgive me saying so, I have listened with still greater interest to Prof. Bone's views on the origin of radiation. Obviously I am not in any way competent to speak about that, but I must admit that during the past few years reading the various papers in the Technical Press on the origin of radiation I have felt, in common with someone much more famous than myself, that every day I know less and less about more and more. But so far as the purely thermal side of the problem is concerned it seems to me that what you are after is to get a gas flame—considering merely the gas fire in its present form—to give up heat as quickly as possible to the radiants and to get the radiants to give up heat as quickly as possible to the room. A thin form of flame like that would part with its heat mainly by convection to the radiants, and that depends on the size and shape of the radiant. The radiation to the room depends on the emissivity of the surface, its temperature, of course, and on the temperature of the surfaces that are exposed in the room. It is a very complicated problem to get exactly the right material and the right shape for the radiants, particularly if you are going to be interested in selective radiation effects, and I doubt very much whether the problem is really amenable to theoretical considerations and whether investigations will not have to be along practical lines and perhaps, in a sense, rather of a hit-and-miss order. Personally, I should think it is probable there will be a considerable development and advance in regard possibly to the material and the design of gas fire radiants, but there is one other point that I should like to bring forward—and that is I do not think it is sufficiently realized that a surface need not be very hot to give a big proportion of radiation, and it always seems to me in view of the large amount of energy that is still left, when you have subtracted the radiation from one hundred—I will not bring in any figures—it is a pity not to catch some more of it.

I think that the design and size of the gas fire is wrong from geometrical considerations. Gas fires are specifically recommended for intermittent use—*i.e.*, you go into a room where the walls are relatively cold and the surfaces are relatively cold, and you turn on about half a square foot at a very high temperature. Quite apart from any wavelength considerations, I think that is wrong geometrically. The wretched human being in his endeavours to counteract 99% of the total subtended angle at a very low temperature has to scorch himself locally, with the consequence that whenever I am sitting in front of a fire reading I feel I want to be on a spit, because I am constantly wriggling my position in front of the gas fire in order to keep comfortably warm all over. Therefore, I think that by some system of a conducting front flue surface above the gas fire with baffles to get out some of the heat, it might be possible to pick up a further proportion of the heat without having that bugbear—of the Gas Press, anyway—of convected heat. It should be possible to have surfaces at moderate temperatures which you can comfortably touch, because a larger proportion of the heat has been given up as radiation.

Mr. C. A. Masterman (Gas Light and Coke Company): Dr. Hartley's well-known association with the development of the modern gas fire lends additional interest to his paper, which deals with certain fundamental aspects of gas fire performance.

The excellence of the modern gas fire must not be allowed to postpone or discourage further improvement and such improvement is to be achieved, not by any happy accident, but by just such considerations as the author indicates in his paper. If criticism is to be offered it is that the emphasis of the principles governing the scrubbing of the heat from the burning gas has left no space in the paper for consideration of the influence of heat conservation.

The aim in gas fire design is not primarily to cause a general maximum radiation of heat but a maximum in a useful direction—that is, into the room in which the fire is installed. Heat conducted through the firebrick backing or heat transferred from the radiant to an excessive current of air passing behind the radiant is largely heat lost—even though it may have had its origin in a most highly efficient scrubbing and emitting system in the radiant itself. Since the amount of heat radiated is a function of the 4th power of the absolute temperature, the maintenance of a high temperature in the radiant is a highly significant factor if a high radiant efficiency is to be obtained. It is an astonishing fact that the heat radiated from the exposed face of the bright gas fire corresponds in amount to that from a black body of equal exposed area of uniform temperature of about 650° C., or dull red heat. The products of combustion leave the top of the radiants at a higher temperature than this.

A bright cheerful appearance is essential, and in practice is obtained by the presence of a number of spots or pips at high temperature while the bulk of the radiation is from surfaces at scarcely visible red heat. A closer structure radiant combined with reduced heat losses from the back of the radiant is found to result in a considerable increase in the emission of forward radiant heat without prejudice to a cheerful appearance or good combustion.

Increased Thermal Efficiency.

There is no doubt that the knowledge possessed by the gas fire manufacturers of the effect of such heat conservation will lead in the not distant future to the production of fires having a considerably increased thermal efficiency. It is possible to anticipate with confidence 7-radiant fires having an unchanged gas rate but giving an amount of radiant heat to the room corresponding to that now obtained from a 9-radiant fire.

Dr. Hartley's figures relating to the effect of various coatings upon radiant emission are of interest. This matter was brought to the notice of the Institution over twenty years ago in Dr. E. W. Smith's Leeds Report; and no final verdict as to the true utilities of special coatings on radiants has yet been reached. Referring to Table III. of the present paper, the coating of rods with uranium oxide leads to an increased heat emission of the order of 15%, and a not dissimilar increase is confirmed in the case of a gas fire by Matake Kurokawa. It is anticipated, however, that the coating of a radiant may show less increase or decrease than the coating of a rod, and Dr. Hartley, in fig. 17, appears to confirm this, the increase with uranium oxide and the decrease with alumina coating as compared to Table III. being very considerably less. Dr. Hartley would no doubt agree that the fit of the radiant to the gas flame is of vital importance in connection with high radiant efficiency; but his further comment as regards the general utility of special coatings would certainly be of interest.

Dr. Hartley in the early part of his paper refers to flame radiation, and suggests that its origin is to be found not primarily in the flame itself but rather in the sheath of hot gases surrounding it. It is difficult to reconcile this conclusion with the known radiant characteristics of flames and with his own reference to Garner's statement as to the marked effect upon infra-red radiation of small quantities of hydrogen in a carbon monoxide flame. Passing reference only is made to the so-called luminous flames, the assumed presence in which of solid particles should lead to a considerable increase in radiation as compared with the aerated flame; but this increase, in fact, is not realized. From the combustion point of view, the behaviour of the tip of the flame is of considerable interest, and Dr. Hartley refers to his stroboscopic tests, as a result of which he confirmed the vibratory movement in this portion of the flame. In the absence of such movement it is difficult to understand how combustion can ever be complete since the rate of diffusion inwards of air into the partially burnt gases would be insufficiently rapid to allow the chemical reaction to proceed to completion.

The author refers to the conditions governing the thermal balance which must exist on a solid body inserted into the flame. The suggestion is that since the heat input from the flame and the heat output by radiation is governed by the same emissivity, certain conclusions must follow. Although this is broadly true as affecting the particular case of a rod in the flame, it is certainly not necessarily true of a gas fire construction where the heat input surfaces and the heat output surface may respectively be the back and front of the front radiant structure. If the front surface is of high emissivity a high degree of radiation to the room may be obtainable without prejudice to the temperature of that surface, provided the material used is of high conductivity and the back surface is so arranged as to be a

highly efficient scrubber of heat from the hot gases with which it is in contact. If the gas fire radiant is considered as performing two functions, the front giving the bulk of the heat radiation while the back contributes the cheerful appearance, then any attempt to improve the radiant efficiency will concern itself more than hitherto with the front structure considered as the radiating surface.

I think this is an opportunity I should take for expressing my appreciation of the gas fire makers and testifying to the friendly relations that exist between the people in their laboratories and those in the laboratories of the various gas undertakings.

A Question of Principle.

Mr. H. J. Hodsman (Leeds University): In the summary of his paper, Dr. Hartley states that the energy radiated from freely burning flame emanates principally (about 85%) from the heated products of combustion " without the flame." Later he softens this statement by saying that " Some six-sevenths of the total emission appears to come from the outer cone and outer heated products." I trust Dr. Hartley will be able to reconcile these statements, because, it seems to me, that a question of principle is involved here.

Helmholtz, from his experiments, concluded that the quantity of radiation from a hydrocarbon flame was determined by the number of molecules of CO_2 and H_2O formed. This theory is simple, attractive, and has found its way into the literature. It would fit Dr. Hartley's conclusions that the radiation practically all comes from the products without the flame.

The theory was, however, destructively criticized by Haslam, Hunneman, and Lovell (Ind. Eng. Chem. 1925, 272), because it took no account of the influence of aeration on the radiation revealed by Callendar's experiments and now confirmed by Dr. Hartley's own observations. In fig. 6 (Curve B) it is shown that the radiation for non-luminous coal gas flames varies from 10 to 16% as the aeration varies between about 2 to 5. If the radiation came almost entirely from the products without the flame, it is hard to see why the radiation should depend so much on whether the combustion was taking place in the inner or the outer cone, for that is the main effect of varying the aeration.

On the other hand, if the radiation is associated with the actual chemical reactions during their occurrence in the flame, it would not be surprising that aeration made some difference. Dr. Hartley himself quotes evidence from other workers that conditions in the flame are not without influence on the quantity of heat radiated.

Most people will be surprised to learn that the visible flame constituted a very minor share of the radiation.

Doubtless Dr. Hartley's conclusions are based on more evidence than is indicated in the paper, and it seems that his views on the source of radiation might with advantage be elaborated.

Some years ago, Mr. H. H. Thomas, " Gas Journal," 1928, Dec. 19, now in the service of the President's Company at Liverpool, made some measurements for me of the radiation emitted by gas lighting burners below a horizontal plane through the burner. Measurements made on the flame of a laboratory bunsen gave a radiation of 10-12% in the lower hemisphere. Now if the radiation emanated almost entirely from the products after leaving the flame, this figure seems, from geometrical considerations, surprisingly high, and calls for further investigation in the light of Dr. Hartley's paper.

Incidentally these measurements showed that the radiation from lighting burners was considerable, and capable of considerable modification if the designer wishes to make the most of the lighting burner for space heating.

Influence of Radiants on Flame.

Mr. James W. Wood (Research Chemist, Leeds University): I would like Dr. Hartley to express an opinion as to whether radiants can or should be made to fit flames, or whether radiants exercise such a strong influence upon the flame characteristics that the form and dimensions of the free-burning flame are of minor consequence. This consideration affects the design of both lighting and radiant-heating equipment.

In making calculations Dr. Hartley has assumed *complete* combustion of gas. It is well known, however, that in the case of the gas fire under fair working conditions the exit gases may contain as much as 1-2% of the heat value of the fuel in unburned form. This was demonstrated during our own CO investigations and appears in the CO-CO_2 ratio curves given in Dr. Hartley's paper.

Has Dr. Hartley any decided views as to whether the front bars of radiants should be increased in thickness any further than is necessary for mere mechanical strength? It is a question as to whether the higher temperatures thus realized as the radiating surfaces will compensate for the smaller holes available for emission in a forward direction.

One very important point is that of the permanence of materials incorporated in radiant material and their liability to loss of efficiency by physical or chemical change when heated for prolonged periods. To the eye some of the newer radiants do definitely deteriorate in one season's use. The thickness of layer necessary to produce the effects indicated is not given. This again is an important matter, for if a thin film is sufficient then serious damage could be done to an otherwise satisfactory radiant by the deposition of ferric oxide either as the result of the combustion of the organic portion of iron-carrying dusts, the decomposition of iron-carbonyl in the gas, or the segregation of iron compounds in the radiant material.

Finally, while thanking Dr. Hartley for bringing this subject before us I should like to ask whether he ever expects greatly to exceed 50% radiant efficiency with gas fires, or whether advance beyond this point must be in the direction mentioned by Dr. Fishenden, of receiving heat from the exit gases, where these contain more than is necessary for efficient ventilation.

Mr. W. E. Benton (Cannon Iron Foundries, Ltd.): We are greatly indebted to Dr. Hartley for giving us this summary, not only of research work published during recent years, but also of the experiments made in the laboratories of Messrs. Radiation Ltd. The only other authoritative account of the subject of recent date is, I suppose, the chapter on " Radiation from Gases and Flames " in that excellent book " Calculation of Heat Transmission " by Dr. Margaret Fishenden and O. A. Saunders.

The periodic character of the flame, observed by looking through a stroboscope, is interesting and reminds one of the jet-tones (spalt-töne) observed by Kreuger and Schmidtke in connection with water and air jets. In those cases the frequency is proportional to the velocity and inversely proportional to the diameter of the jet, the waves being due apparently to the formation of vortex rings, alternatively inside and outside the main moving stream. I am not at all clear as to the meaning of the figures in Diagram 1, but possibly a similar sort of relation could be deduced from the experiments cited.

Flame Velocity.

With reference to the calculations of flame velocity from measurements of slope cone-height, it is interesting to note that by putting $r = h$ in the equation, one can determine at what gas-rate for any particular aeration the flame will endeavour to light-back into the burner. This is useful in calculating the most suitable size of drill to use in hotplate burners, where the main burner chamber is not protected by any grid or mesh. There are two obvious criticisms of this well-known formula: (1) It offers no explanation of the familiar phenomenon of flames " blowing-off " at high aerations or pressures; in fact, one might say that it does not recognize the possibility of such a thing; and (2) it does not take account of the true shape of the so-called " cone," which nearly always has a rounded apex (see fig. 1), and is in fact more like a hyperboloid of revolution than a true cone. The formula can also only be applied when the velocity is uniform over the cross-section.

In Fig. 7 the curves represent the variation in the emission of heat as one traverses a cross-section of the flame. If one considers each unit volume of this disc of flame to be emitting radiation in a forward direction and at the same time absorbing part of that which comes from the elements behind it, one can integrate and obtain the total emission from any thickness of flame. Now assuming the cross-section to be circular one can derive an expression for the variation of the intensity of emission across the diameter. Differentiating this expression one finds that the rate of fall of intensity as one moves from the centre across the flame should be proportional to the distance from the centre. Put algebraically

$$-\frac{dE}{dx} = 2a\lambda\left[2\frac{\epsilon}{a} - E\right]$$

A few minutes' calculation, using Dr. Hartley's curves, shows that this is remarkably well borne out, over the width of visible flame. These curves, therefore, show definitely that the inter-conal gases behave as a volume of uniformly radiating and absorbing gas.

Figs. 10-16 show the variation of galvanometer deflection with wave-length for various substances. It seems a pity that these curves were not corrected for dispersion, as one is tempted to assume that the areas enclosed are proportional to the total amount of heat radiated. This of course is only true when the curves are plotted in the standard form $E/\delta\lambda$ against λ. Assuming minimum deviation in the prism, and using the data given on p. 32 of the communication, with the well-known dispersion curve for rock-salt, one can make an approximate correction, but as the curves stand they are of qualitative significance only. No

reason is given for the apparently random choice of the substances illustrated. Presumably a systematic search was made, following the work of Coblentz and others, until the required substance was found. Now the net result of this investigation would appear to be:

(1) That by temperature alone it is not possible with atmospheric burners to shift the peak of radiation appreciably towards the left.
(2) That by the use of special substances, particularly uranium oxide, the relative amount of short wave-length energy can be notably increased, and
(3) That although this discovery can be applied successfully for therapeutic purposes, its effect is largely lost when applied to gas fires.

Now although radio-therapy is a new and valuable field for the utilization of gas, it is to the improvement of the gas fire that we must look for the greatest possibilities of increased gas sales. That the improvement in gas fire radiants in recent years is definite, and in the right direction, is well established, but if this prolonged investigation only indicates that there is apparently a limit to further advance, then surely we must look to other methods to attain the end desired.

We, the Cannon Iron Foundries, have been engaged on this problem for several years, and some time ago a possible solution was indicated by the results of some experiments carried out by the Thermal Syndicate, of Wallsend, the makers of "Vitreosil." The results of these experiments are also contained in fig. 10. The substance Vitreosil, or fused quartz, has an emission spectrum showing very low intensities up to 2μ, and the great bulk of its emission is between 3μ and 5μ. Now "transparent" Vitreosil will absorb just those wave-lengths which, when heated, it would emit. Hence by passing the radiant heat from a gas-fire through a screen of Vitreosil, the "scorching" part is completely absorbed, and only the much desired short infra-red is transmitted. The immediate application of this to radio-therapy is obvious. By using more intense sources and screening with Vitreosil, a fairly "pure" beam of short infra-red energy could be obtained. Now to suggest the use of a quartz screen in front of a normal gas-fire is manifestly ridiculous, as the loss of efficiency due to absorption is considerable. An early though imperfect anticipation of this idea is contained in the old-fashioned glass fire-screen. We saw at the outset that to obtain the best results from this discovery we must make a gas-fire in which the combustion should be equal to that of a freely-burning flame, so that the products of combustion could be used for convective heating. We have, we think, overcome this difficulty and hope shortly to bring out a portable gas-fire having a reasonably good radiant efficiency, and producing perfectly harmless products of combustion. (Patents have been taken out by both the Thermal Syndicate and the Cannon Iron Foundries in this connection.) The heat radiated from this novel gas-fire will be almost entirely of short wave-length energy. The radiant efficiency will, of course, be lower than that of an inclined gas-fire, but with the high degree of combustion the whole of the remainder of the net calorific value will be available for convective heating.

In diverting your attention to these few points I would add that to criticize is easy, but it requires little imagination to realize the very great amount of work that has resulted in the preparation of this paper.

A Diffusing Envelope.

Dr. Burrows Moore: Dr. Benton has already said one or two things which I had intended mentioning, but in connection with the subject which Dr. Hartley has so well presented to us, I think there is a stage which requires further investigation—and that is the effect of using a diffusing envelope for the heated radiant. Although the infra-red region in connection with therapy is not quite clear yet, it is clear, so far as the available evidence goes, that the main region of interest is that from 1 to about 6μ, and of that region the range from 1 to about 2·2μ is the more desirable range, and from about 2·5 to 6μ is the less desirable range—inasmuch as it has not any great penetrating properties and tends to over-heat and cause discomfort. The amount and quality of radiation transmitted from any transmitting medium obviously depends to a large extent on the absorption and scattering of the radiation within the medium, and if one considers the mechanism of absorption and scattering, it is reasonable to think that the use of transparent or semi-transparent materials, particularly if they contain within them a finely dispersed phase, is likely to prove some sort of selective transmitter. In connection with this aspect, we have recently obtained some results at the Thermal Syndicate laboratories. In the first place, I should like to mention that translucent fused silica, which is a medium containing a finely dispersed gas and finely dispersed cavities, has a marked selective characteristic for the ultra-violet. Further, experiments have shown also that it appears to have a less marked selective characteristic in connection with the infra-red. I had brought with me two slides which I am sorry I cannot show because facilities do not appear to be available, and they would have shown you the results more clearly than I can explain. The slides show the intensity corrected for dispersion plotted against wavelength for, first, a bare radiant formed by an electrically heated wire covering a vitreosil tube. The second slide would have shown the same radiant but covered with a translucent vitreosil envelope. The two radiants were operated at the same watts dissipation, and the curves show that if one considered the area under the curves in both cases, the ratio of the area for the region 2·2 to 4·5μ divided by the area for the region 1 to 2·2μ, for the bare radiant is equal to 3·5, and for the covered radiant the ratio is 2·5—indicating that the vitreosil envelope has selectively reduced the undesirable region of the infra-red in favour of the desirable region. That the results were not due to temperature differences was shown by similar experiments with bare radiants deliberately run at higher temperatures, and the conclusion I think is that translucent vitreosil is one of the materials which has selective transmitting properties and is in favour of the shorter and more desirable radiation in the infra-red region.

Comparing Visible Radiant Energy.

Mr. L. H. Sensicle: I should like to say that the only qualification I can put forward for speaking on this subject is that about three or four years ago I was very interested in the different effects which were obtainable with different types of gas fire radiant. We went into the matter in a certain amount of detail and developed a method of comparing the visible radiant energy from different makes of radiant and also from radiants coated with different chemicals such as cerium compounds, thorium compounds, &c. I know that the proportion of the energy emitted by a gas fire in the visible portion of the spectrum is exceedingly small. At the same time, attention has been called this morning to the value of a cheerful appearance in a gas fire, but I do not think it is only a question of appearance. There is a most important matter arising out of this about which we have not heard very much in the last two or three years. Messrs. Radiation Ltd. published some very interesting data three or four years ago about which they have been extraordinarily silent since. They went into the question of the absorption of the infra-red rays by the human skin, by water, &c., and they found that the human skin absorbed very strongly at certain wavelengths which unfortunately we find are very intensely emitted by the gas fire. It looked at the time as if they were on the track of doing something extremely useful with the gas fire, but apparently they have decided that it would be very difficult to eliminate these dangerous wavelengths without cutting down the efficiency of emission from the fire to an impossible degree. Personally, I suggest that the matter ought to be carried further, and that there may be a solution found to that difficulty. I should like just to record the fact that the most comfortable radiation is that from the sun at 0·6 michron wavelength. The electric arc comes next with the maximum emission of 1·5 michron, and the incandescent burner comes very close with a maximum emission at 1·6 michron, and if we refer to the curves in Dr. Hartley's paper we find that the maximum emission is somewhere about 2·8 to 4·45 michron. It is a very interesting fact that in all these curves we get the two maxima 2·8 and 4·5 recurring.

Dr. Hartley: The figure is 2·3 and that is rather a significant difference.

Mr. Sensicle: These correspond with the emission from the formation of water and CO_2, and it occurred to me that it might be possible to utilize the incandescent mantle in some way for gas fire construction. I simply put it forward as a suggestion. It would mean quite a lot of work probably in designing a method of constructing a fire; it might be possible to have ordinary mantles with an amber tinted vitreosil screen in front to reduce the glare, or alternatively, a number of small inverted type mantles set horizontally in staggered formation projecting from a fire clay back flue, also with an amber tinted silica screen in front to reduce the glare. It seems to me that the great thing to aim at in the gas fire is to have a maximum radiation emission below a wavelength of 1·9 michrons, which is the lowest wavelength at which water absorbs selectively. That selective absorption of water would seem to be intimately connected with the scorching effect that one gets on the skin. One of the root problems to be solved in the future is that of obtaining something approaching uniform warmth on the part of a person sitting near a gas fire.

The Chairman: I should like to thank Dr. Hartley for his courtesy in agreeing to give his reply in writing.

30th Report of the Joint Research Committee of the Institution and Leeds University

Report on the Sigma B.Th.U. Recorder

Research Chemists: James W. Wood, M.Sc.Tech., A.I.C., and F. J. Dent, Ph.D. *Research Assistants:* W. H. Blackburn, Ph.D., N. H. Williams, M.Sc., E. Parrish, M.Sc.Tech., A. R. Kelly, B.Sc., and J. W. G. Davey, B.Sc.

Mr. A. Blackie (Fuel Research Board): I would first like to congratulate the Committee and Mr. Wood on the very careful investigation which has been carried out on this calorimeter. Their report contains all that any user is likely to want to know, and is rendered still more useful by the interesting appendices which have been added. The Sigma instrument being an inferential one, it is not fair to compare its accuracy with instruments in which the calorific value is measured directly, but I think that all will agree that Dr. Stewart in his design has succeeded in combining simplicity and robustness with a degree of accuracy which meets practical requirements in a very successful manner.

In the years 1926 and 1927 the Fuel Research Station obtained one of these instruments with a view to testing its capabilities for gas control purposes, and a number of tests were carried out upon it. These tests and a number of tests on other gas appliances have not been published. I have, however, permission to refer to them briefly at this meeting. I do so the more readily as they in general confirm the conclusions of the present report. I will, therefore, briefly summarize our experience under some of the headings dealt with in the report.

Governing.

On the original instrument tested there was only one governor at the top of the gas inlet tube. The governing under these conditions was not perfect, and effects of changes of pressure in the gas supply were not entirely eliminated. At our suggestion, I believe, an additional governor was put in series with the first, as in the present form of the instrument; and on re-testing no complaint could be made in regard to the steadiness of the final pressure before the lower governor. With pipeline pressures of from 10·2 in. to 1·2 in. of water this pressure remained quite constant at 0·326 in. of water.

Compensation for Changing Specific Gravity.

This was good, but not perfect, a low specific gravity still giving slightly higher rates of gas passage. Two gases of about the same calorific value but of very different specific gravity gave results, as follows:

Sp. Gr.	Pressure.	Rate of Flow. Cu.Ft./Hour.	C.V. by Boys	C.V. by Sigma	Difference.
0·543	2·9 in.	0·781	359·5	352	− 7·5
0·180	2·9 ,,	0·862	384	389	+ 5·0

Hence a change of specific gravity from 0·54 to 0·18 only gives a change of about 3% in the reading of the instrument, so for ordinary fluctuations these changes may be practically neglected.

Changes in Barometer and Temperature.

Compensation for these changes was on the whole satisfactory but not quite complete. The fluctuations of the gas factor are much reduced in the fluctuations of the record of the instrument when run on a gas of constant calorific value.

An analysis of such runs showed that at such times as there was a constant temperature and a varying barometer an increase of about 0·1 in. on the barometric pressure gave a fall of about 1 B.Th.U. in the record. With steady barometer and fluctuating temperature it was found that a rise of temperature of 1° C. gives a fall in the record of about 1·1 B.Th.U. This is the reverse of what is to be expected if it is merely a question of change of density of the gas. Experiments were then made in an endeavour further to elucidate the cause of this.

The air for combustion was warmed, other temperatures not being changed, and it was found that warming this air about 14° C. gives a fall of about 2 B.Th.U. This is in the same direction as the effect found from analysis of records but of negligible magnitude.

The air outside the outer jacketing tube was then heated independently by an auxiliary jacket, the combustion air remaining at normal temperature. The mean temperature of the jacket tube was measured by thermocouples, and it was found that the record rose as its temperature was increased thus:

Rise of Temp. of Jacket.	Rise of Sigma Record.	B.Th.U. per °C.
°	B.Th.U.	
10·5	6	0·57
12·9	10	0·69
18·2	14·5	0·80
26·0	29	1·16

This effect is in the opposite direction to the other and of greater magnitude, and is clearly connected with the different states of radiation and convection.

Results obtained in this way are, of course, inconclusive and not directly comparable with those obtained in a uniformly heated room. This condition was, however, impracticable in the circumstances, and I would suggest to Mr. Wood that should an opportunity occur for such tests it might throw light on some of the remaining causes of error.

Draughts.

In the attempts to obtain a uniformly heated room for the above experiments a fume cupboard fitted with an electric heater used with and without a fan and baffles was arranged. This failed for the purpose intended, but it was found that the scarcely perceptible down-draught of air past the instrument due to the heater in the opposite side of the cupboard caused a rise in reading of 36 B.Th.U., while when the flow of air was reversed by means of the fan and baffles a fall of 40 B.Th.U. was observed even when the heater was not in action. In the former case the natural convection from the instrument is opposed, and in the latter, aided. This simple experiment shows the extreme importance of avoiding draughty positions for the instrument.

Response to Variations.—The instrument was run with a Simmance recorder on a variable gas. It smoothed out minor variations more than the Simmance, but reacted more rapidly to the major ones.

Mechanical Parts and zero keeping were good, and very little attention and maintenance were required.

General.

It is usually reliable to within 10 B.Th.U., or, say, 2%, but in abnormal circumstances the error may be 20 B.Th.U.

On the whole, I think the conclusions of the report as to the uses of this instrument are exactly what our experience has shown.

Dr. J. G. Stewart: I wish to express my appreciation of the thoroughness with which the Committee and Mr. Wood and Mr. Davey have investigated the accuracy and behaviour of the Sigma B.Th.U. Recorder. The most interesting part of the report is that dealing with the gas flow regulator, in its measurements of the pressure thrown by the governors and of the gas rate. During any one period between the intervals of cleaning the governors, the error observed in gas rate was ± 1·7% with 90% of the readings within ± 1%. This is the interval of practical interest, as users would invariably check the reading after cleaning the valves. While these figures represent good pressure governing, I do not think they represent the possible limits with diaphragm governors, some recent modifications giving promise of greater accuracies. There is a mention also about the fouling of the valves; and the modifications I have been making really relate to that. The fouling of valves is due largely to the wire-drawing as the gas passes through the upper valve, and that can be diminished by adjusting the initial governor to a much smaller pressure. That leaves the valve more fully open, which is an advantage and reduces the wire-drawing. It also has a bearing on the point raised in the report about the valve not hanging centrally. If the valve is clean it need not hang centrally. I have tested these governors by tilting them through a considerable angle without changing the reading, but if the valve is dirty it becomes important that it should hang centrally in its seating.

The report suggests the substitution of oil-sealed bells for diaphragms. I have had governors of this kind in experimental use for some time. Such governors are more sensitive; and I anticipate a considerable improvement in accuracy by using them, but I have not yet sufficient data to state the limits of accuracy. It is probable that they would not meet the conditions in the smaller gas-works as well as the diaphragm governors, which can be reduced for cleaning and re-adjusting, and easily replaced by the gas-works fitter.

Unfortunately, I have no collected results of accuracies of recorders which have functioned to the satisfaction of the users, but many have stated to me that they get results well within ± 2%, often nearer ± 1%, over periods of four to six weeks. The report mentions a sudden change in the error after renewing the chart and winding the clock. This is probably caused by straining the magnifying mechanism by moving the pen. In the No. 3 Recorder, to avoid this possibility, the pen should be taken off when putting a new chart in position. In the No. 1 Recorder the pen is held by a fork, so that it can be lifted out of the fork and turned to one side, thus freeing the mechanism from the pen.

Accuracy of Driving the Charts.

The report mentions difficulty in adjusting the beat of the pendulum of the clock and stoppage. Similar experiences led us a year ago to modify the escapement, and each clock is now capable of running with a driving weight only half that supplied to the user. At the same time, the adjustment of the beat is less sensitive. With regard to accuracy of driving the charts, we have not noticed errors of the magnitude stated, and think they must be related to the same imperfections of the escapement.

The sensitivity of the Sigma recorder to small changes of calorific value is compared with that of the Fairweather; and it is thought that the smoother line of the Sigma record indicated that it is less sensitive. While there are limits to the sensitivity of the diaphragm governors, I think it more likely that the small changes on the Fairweather chart are due to imperfect mixing of the water before reaching the air bulbs of the thermometers. I have found air bulbs more sensitive to small and rapid changes of temperature than the mercury thermometers; and I have been able to produce smoother curves by improving the mixing. When rapid response is required it should be remembered that the gas consumption of the Sigma recorder is less than 1 c.ft. per hour; and a burner must be fitted to burn off the gas in the pipes leading to the recorder.

In the report no mention is made of the accuracy of the standard calorimeters used. It is known that they may have uncorrected errors due to radiation; and resistance to the rotation of the meter. While these were probably negligible, a statement of their limits would have improved the report, particularly as it is too generally believed that it is impossible to err in using a standard calorimeter.

The report considers it a disadvantage that the Sigma recorder must be set by comparison with an independent standard water-flow calorimeter. I think this opinion wrong. Standard instruments converted into recorders have been known to lose their accuracy in the conversion, and to suffer by continual use. In the highly developed field of electrical instruments it is not considered good practice to embody standards in recorders; and there is no opinion in favour of the change. In calorimetry the Thomas recorder does not "embody any means whereby its accuracy may be verified," and I know of no adverse criticism of it on that account other than that contained in the report. I was very pleased to hear Mr. Blackie's remarks. I have not had a chance of reading the report of the experiments which he did. They were done in 1926, but several changes have happened since then. The Sigma recorder, like any other, needs continual watching; and one experiments to make modifications as difficulties arise in the gas-works.

Influence of Draughts.

In regard to draughts, I think the instrument to-day has not the sensitivity of the instrument Mr. Blackie has. The part most sensitive to draughts, of course, is the gas flow regulator; and any slight draught blowing on one of the cubicles can upset it quite a large amount. On the other hand, if the whole of the gas flow regulator is some distance away from an open window or door, with draughts blowing on it, the instrument frequently works exceedingly well with very small errors. A case in point to which my attention has been drawn is at Burnley, where the recorder was working in the new gas-works. A window accidentally blew in, and quite a storm was blowing through the space where the window previously was. Under these conditions, however, the instrument worked extremely well and everybody was very pleased with it. On the other hand, if you get a governor near an open slit at the top of a window, you will then probably get very much larger errors.

In conclusion, I should like to say that I think this report is exceedingly valuable; it is valuable to me, and I hope users will find it valuable also.

Mr. W. J. A. Butterfield: In anything I say you will understand that I cannot deal with any question of the policy of these instruments being prescribed for official testing. Subject to that, there are a few comments I should like to make on this extremely useful report. I think the authors are to be heartily congratulated on the work they have done. The report is an extremely useful statement of the principles of the instrument and of its behaviour under varying conditions. The contribution that I can make to what is stated in the report is solely in regard to knowledge of the behaviour of the instrument in other conditions through the records which have come to the Gas Referees' office from a large number of places.

As regards inferential instruments generally, this instrument, a few years ago, was found by myself and my colleagues to be the best of the inferential recorders, and so far as I know it remains as good as any other to-day. It is not mentioned in the report—and it is only fair that it should be known—that another inferential instrument is now approved by the Gas Referees as an alternative to the Sigma. That is the R type of Simmance Calograph; and we are satisfied that its behaviour is substantially as good. They both seem on a par as far as we can judge.

An Instrument Above the Average.

The report deals mainly with one Sigma instrument; and I think it is fair to say that this particular instrument was probably above the average in behaviour. Its correction for tabular conditions was rather better than the average of those instruments; and it appears to have had greater freedom from unexplained aberrations. But in considering this report you should bear in mind that it was an instrument rather above the average—not the best of which we have knowledge, but certainly somewhat above the average. Another favourable condition in which the observations were made was the stream of gas on which it was tried. The Meadow Lane Works gas, as shown by the official records of the Fairweather calorimeter, is one of the most uniform of the supplies from big works. There are others quite as uniform, perhaps slightly better, but you could hardly have chosen more favourable conditions as regards the gas supplied in which to test an inferential instrument. I do not think Mr. Hardie will mind my saying this, that the gas on which this instrument was tested is more uniform than we ordinarily get in Westminster. The Sigma instrument on our supply is undoubtedly more affected by the slight fluctuations. You must understand, however, that the changes experienced in Westminster are due to the fact that the draught in the mains is in one direction at certain periods and in the other direction at other periods. The supply is not always from the same gasholder station; and that naturally introduces changes which would not be found on a single works' supply of the London Companies.

As nobody from the Uddingston Gas-Works seems to be present, I will, at the risk of a breach of confidence, read a letter which came from Mr. Royden earlier in the month. This reads as follows:

> "We have now had our Sigma recorder working on official tests for twelve months; and think it might interest you to know how it compares with our own works test. These tests are carried out on the standard Boys calorimeter in strict accordance with the specification. The gas supply comes from a continuance of the service supplying the Sigma. The average quarterly results are as follows:"

From the letter it appears that they have made something over 200 non-recorder tests each quarter, and have compared the average of these with the average of the Sigma charts; and it is summarized in this way:

> "This gives 402·0 B.Th.U., as the average for the twelve months from 868 tests, compared with an average from the chart of 401·9 B.Th.U. for the same period. It is also interesting to note that the average of the Gas Examiners' non-recorder tests—52 in all—is 402·0 B.Th.U. We shall be glad to hear if such close agreement is general."

The agreement, of course, is marvellous—[laughter]—and in reply the Gas Referees, among other things, said:

> "Your Sigma recorder was among the first of the instruments of this type to be used for official purposes, and the information at present available regarding the behaviour of other contemporary Sigma recorders is not sufficient to enable the Referees to say definitely that the close agreement shown by your instrument is general. The indications are, however, that the agreement in the case of your instrument is exceptionally good, and it is no doubt due in no small measure to

the close control of calorific value exercised at your works and the provision made by you for ensuring that the instrument operates under conditions conducive to satisfactory behaviour."

That bears on the point I have already mentioned about the uniformity of the gas. That is gas made entirely in vertical retorts, and is undoubtedly extremely uniform. The chart from that works was one of those which I reproduced in a paper which some of you will remember I read at Birmingham earlier in the year; and it was the straightest line of all the curves shown. One factor that may contribute there—although I do not know that it does—is that probably the manufacture of the gas is controlled by reference to the Sigma record, and not by reference to some other recording calorimeter, which invariably compensates for the tabular conditions. If you control the manufacture by the Sigma instrument, naturally you will get a straighter line, irrespective of whether it varies or not with the tabular conditions; and that may account for some of the straight lines from some of the smaller works.

There is just one point more. The authors say that the record obtained from the Fairweather recorder is not quite as smooth as that from the Sigma recorder, and suggest that the Fairweather instrument is the more sensitive and they conclude by saying: "The damping out of minor fluctuations may in practice be no disadvantage." Generally speaking, the Sigma instruments of which I have close knowledge do rather amplify the fluctuations than otherwise, but that is a matter really for the instrument makers for the adjustment of the magnifications. As to damping-out of minor fluctuations being no disadvantage in practice, that is, I think, a comment with which most of us will concur; and the Boys recording calorimeter was deliberately planned by Prof. Boys to damp out minor fluctuations. The governor troubles appear to depend largely on the character of the gas; and that is why the Sigma recorders in some places give much more trouble than in others, and less satisfactory results. Wire-drawing of the gas causes trouble which may partly be avoided, as some of you know, by putting some filter just before the instrument. We have recommended a roll of fine wire gauze about 6 to 8 in. long inserted in the pipe in front of the instrument, and that, in some cases, has kept back tar or resinous deposit and given the governors a longer life before they need cleaning. Wire gauze is better than cotton wool because it does not get soaked with moisture if the room happens to get cold and the gas is not dry gas.

What I have said about the character of the gas affecting the behaviour of the instrument brings me back to the first point—viz., that each of these instruments must be judged independently. You cannot take the Sigma instruments as a class and say that you are certain of any particular behaviour. There are differences between the individual instruments which cannot at present be accounted for, I think, and which are the cause of a good deal of uncertainty.

Mr. GILBERT B. HOWARTH (Chief Chemist, Newcastle-upon-Tyne and Gateshead Gas Company): We have a number of Sigma recorders in operation in the Newcastle area, but have had neither the time nor the facilities for an exhaustive study of their working, and in consequence we are particularly pleased to receive the results of the very thorough examination undertaken by Mr. Wood and Mr. Davey. We are not concerned with these instruments for official purposes, but use them for works control, and our impressions naturally have reference to that point of view.

I agree that on an ordinary town supply the fluctuations of calorific value will be correctly averaged. On a "make" stream, however, the fluctuations assume a systematic character—a rapid rise soon after charging being followed by a gradual fall as carbonization proceeds. The lag during the rise will be greater than that during the fall, and owing to the difference in duration, gas quantity and gas composition for the two portions, it is extremely doubtful whether the average of such a curve is really acceptable. In such circumstances the checking of the instrument presents great difficulty. A single test is invalidated by uncertainty as to lag. A series of tests throughout a complete cycle gives good results, but is too tedious for routine work. Changing to a steady gas stream of different composition has obvious defects. Any suggestions on this point would be welcomed.

Table X. reveals a very curious situation. It shows that correction for temperature, pressure, and specific gravity of the gas cannot be made perfect, but is very good for gas of specific gravity 0·5. Our gas is not far from 0·4, for which the correction is less satisfactory, and it is therefore not surprising that with daily checks we can hardly reach the accuracy of ± 1% indicated at the end of the Summary.

Variations in the humidity of the air have no effect on the control column when once the loading of the govenors has been established. They may, however, influence the conditions of heat transfer in the chimney, and thus alter the reading. It would be useful to have tests on this point.

We have sometimes found inaccuracy in the pen-ratio, but when once the correct size of orifice has been fitted the figure is easily maintained within a reasonable tolerance, and there appears to be no call for the addition of a ratio-adjustment to the pen mechanism.

Only very seldom do we find it necessary to clean the governor and orifice, and we confirm the Committee's view that with reasonable care the instrument is very durable and likely to have a long life.

MR. WOOD'S REPLY.

Mr. WOOD: It is not my intention to reply to the discussion at length at this stage because a number of the speakers have covered ground in common and they are technical matters which are best given careful consideration. Therefore, with the Chairman's permission, I propose to submit a written reply. It is very interesting indeed to hear that our experiences are substantially in accordance with those of Mr. Blackie at the Fuel Research Station, but I should like to know whether he has been working with one of the early types of Sigma instrument which was not quite so well shielded as the present types are with the addition of the fourth concentric tube.

The other matter I should like to mention relates to the principles which should underlie the test. I have received communications from gas engineers, and expressions of opinion, and I have been told that their instruments are never in error by more than 1%; but there is a very good reason for it, and that is that if they have more than 1% error the instrument is *ex-officio* out of adjustment, and is re-adjusted. [Laughter.] That, however, is not a fair way of assessing an instrument which may have to be left unattended for a month at a time, but it is perfectly reasonable for an instrument which is being used for works control purposes. I think the point which Mr. Blackie made—that he has found the errors largely to compensate for one another mutually—is rather a dangerous thing to rely upon. It all depends on the time of the year and the condition of the gas whether such compensation is actually going to be effected or whether you can really rely upon it. I am not quite sure, in the case of Mr. Stewart's remarks, how he overcomes the difficulty of fouling by avoiding the wire-drawing of the gas. I may have misunderstood him, but if he is going to reduce the pressure of his governors, that is only a matter of transferring the wire-drawing to another point of the circuit; but it may be a less sensitive point.

Mr. STEWART: The change was simply in the initial governor where the pressure is 2½ in.; and to reduce that to 1 in., if it gets fouled, does not matter very much. In the second governor the pressure drop is from 2½ in. to ⅜ in., but that, of course, is a different matter.

Mr. WOOD: The other point about a standard calorimeter is one that I have discussed with Mr. Stewart before privately. I do not think you could get a really first-class recorder merely by attaching some recording device to a standard instrument. A general impression of the Sigma instrument is that it is very compact and very simple; but if you take the whole instrument, including facilities for checking, the difference as compared with other instruments is not so very great as it might have been. Mr. Butterfield has already given some very valuable experiences in the paper he gave in Birmingham upon recording calorimetry; and we feel, of course, that there is always a risk in carrying out any extensive research with an individual instrument. Therefore, the information that has been provided regarding other instruments in other parts of the country is most valuable. It is, perhaps, interesting to know that our own Sigma is, perhaps, a trifle above the average. The fact that the gas at Leeds is of very uniform quality is helpful in examining what might be referred to as the erratic behaviour of the instrument. There are quite a number of tests in the report where quite considerable changes have been brought about by artificial means.

We have examined the point which Mr. Howarth brought up concerning the lack of symmetry on the charts in heating up and cooling down, and actually we should prefer to repeat some of that work with a specially adjusted instrument with the chart driving at a greater rate, because with a time scale of ¼ in. per hour it is impossible to be certain about the lack of symmetry in heating up and cooling down, although theoretically it ought to be there. I am rather surprised that Mr. Howarth finds it necessary to clean his instrument so rarely, because the bulk of the trouble we have had reported to us is through fouling of the governors.

The CHAIRMAN: I should like to express my deep and sincere appreciation of the honour our President has done me in so courteously and kindly asking me to preside over this meeting.

32nd Report of the Joint Research Committee of the Institution and Leeds University

Test of the Intermittent Vertical Chambers at Croydon

Research Chemist: F. J. DENT, Ph.D. *Research Assistants:* W. H. BLACKBURN, Ph.D.; N. H. WILLIAMS, M.Sc.; E. PARRISH, M.Sc.Tech.; A. R. KELLY, B.Sc.

The PRESIDENT (Mr. Ralph E. Gibson): I am sure you will agree that we have had presented to us an exceedingly useful report. The work done by Dr. Dent and his helpers has been very thorough, and we appreciate the great care they have taken. The tests have been made on a practical scale on a very large installation at Croydon; and we are greatly indebted to the Croydon Gas Company for allowing the tests to be carried out there.

Mr. W. GROGONO: I am very much obliged to you for your expression of thanks for the work we did at Croydon; and I must say at once that we thoroughly enjoyed having Dr. Dent and his assistants down there. Turning to the report, I should like to say how very gratifying it is to us to have these results published, because they are ahead of the results that were published when the plant had done eighteen months' work. The plant has now done another fifteen months' work, and the therms over that period have been 76½ on 530 B.Th.U. gas, whereas you may remember that at the end of the first eighteen months' working the therms were 74·38 on a 552 B.Th.U. gas. Since the first eighteen months, the temperatures have been raised very slightly; and that has given us the increased yield. No alteration of any description was made in working the plant during the period that the Research Committee carried out this test, with one exception, and that was we had to split out the liquor and the tar which, before the test was made, was being mixed with the tar and liquor from the horizontal plants.

In the report is given the composition of the waste gases entering the recuperator and also entering the waste-heat boilers. These results show that there is a certain amount of leakage of air; but, of course, that includes the whole of the waste ducts going to the boiler, which in our case are overhead steel mains brick lined. A second point is the amount of steam admitted to the ovens; and in this connection I should like to say that the whole of that steam was metered, and not calculated theoretically on the pressure of the steam and the size of the orifice.

In the report is shown the amount of water and steam used on the producers, and the amount of steam appears to be very low in proportion to the amount of water. It should, however, be borne in mind that the area of these producers is very large, and that practically the whole of the water used is evaporated.

I am extremely glad to hear that Dr. Dent and his assistants are coming to Croydon later on this year to carry out further work on the water gas plant; and I should like to add that we are looking forward to seeing them very much.

Mr. F. B. RICHARDS: I should like first of all to compliment Dr. Dent and his colleagues on the thoroughness of the work they have carried out and the excellent manner of its presentation. I think it is presented in a form in which it is peculiarly readable, and could hardly have been improved upon. There are one or two points I should like to touch upon. The value of the work, to my mind, lies very much in the fact that it is not a specially prepared test but is a series of observations of daily working, and I think the bearing of this is very important, because it gives everyone concerned, and particularly the designers of the plant, the maximum help in giving them a lead as to the order and importance of the different factors that have to be taken care of in design. For example, it gives us such a clear definition of how the heat losses are distributed. In that connection I should like to ask Dr. Dent one question. He uses the words "heat passed through the walls of the chambers," and one is led to believe that what is actually meant there is heat used or distributed in the setting. I am not quite sure whether that is heat only transmitted through the walls, or whether it also includes losses by radiation, convection, and so on.

Another point that struck me as being of special interest is the ingenious type of thermocouple used to obviate the effect of radiant heat from the walls of the flues, and therefore to ascertain reliably what was the temperature of the secondary air. It has occasioned everyone who has had to go into this matter a great deal of thought as to how it can best be done. I think the method adopted here is one which will find general acceptance; if it does not entirely eliminate the effect of radiant heat from the walls, it certainly goes a long way towards doing so.

I should like to comment on a matter already mentioned by Mr. Grogono regarding the yield of gaseous therms consequent on the slight increase in temperature of the settings. In the discussion which took place on Mr. Grogono's paper before the Southern Association, that point was put forward as a suggestion. It has been followed up and with very satisfactory results. Again, the composition of the producer gas is given, and appears to indicate a very hot fire. The CO_2 content is very low. I do not know whether that is good from the point of view of efficiency in heating the setting, but it does entail, I think, some measure of added wear on the producer linings. I do not quite know where is the happy mean between life of linings and efficiency.

Mr. T. CARMICHAEL (Portsmouth): I would first of all take the opportunity of congratulating the members of the Joint Research Committee and of the Research Staff on the very exhaustive and, at the same time, interesting way in which the report has been presented. The economic results obtained fully confirm the similar tests previously carried out at Croydon and Southall, and also a test on a similar type of plant at Portsmouth. Further evidence of the value of intermittent vertical chambers as a process of carbonization in the Gas Industry is thus furnished.

PERIOD OF TEST.

It is gratifying to note that, in common with the previous tests of intermittent vertical chambers to which reference is made, the importance of the period over which the test extends is realized. The adoption of 28 days is fully justified, the sub-division into weekly results showing how desirable this otherwise long period is, if reasonable accuracy is required. I well remember in 1919 approaching our late friend, Sir Arthur Duckham, and asking him to give me a 28 days' Guarantee Test for a new plant of continuous retorts. Although members of Sir Arthur's staff were at first frightened, they afterwards stated when the test was over ("GAS JOURNAL," Vol. CLX., p. 560), that "they wished all engineers would adopt the system of 28 days' test instead of a 72 hours' one." They declared that "28 days was a proper test of a plant."

It may be worthy of note that, although "this type of carbonizing plant, newly introduced," is mentioned, the intermittent vertical chamber is merely a modification of the Dessau plant which has been in use in this country for the past 20 years. The mechanical arrangements of both are identical. It is interesting to note that the bogey of Durham coal seems to have called for special design of the chambers. It would have been of great interest if the details of this had been given. It is observed that a "graded coke pad," instead of breeze, as in the case of a Dessau and of some other intermittent chambers, was used. This is distinctly uneconomical, but I assume the breeze pad has been tried, and I feel sure the members would like to know the reasons for preferring graded coke to breeze. Prof. Cobb may tell us that the coke nut permits an easier egress of the gas to the bottom hydraulic mains and, consequently, a tendency to reduce internal bottom pressure in the retorts. On the other hand, however, the disuse of the bottom offtakes altogether has, on occasion, seemed to have little effect on results, and it would, therefore, be interesting in this regard to know exactly to what extent results given in this report have benefited by the use of a bottom gas offtake and main.

PRODUCERS—INTERNAL OR EXTERNAL.

Although the fact that the installation under test is provided with built-in, or internal, producers is merely de-

scriptive, the question of the relative merits of internal and external producers for such work is important. Since cold coke must be used in both cases, in contradistinction to horizontal practice, the choice seems to be between the slightly greater economy in coke consumption and space occupied by the internal, as against the practical advantages of the facility of repairs and cleaner gas of the external. The statement that " the whole of the chamber is heated to carbonizing temperatures " while perhaps being the general impression of the matter, is not strictly accurate. The variation from 1300° C. at the bottom to 875° at the top, or an average of just over 1080° C., is by no means a modern static carbonizing temperature. This reference to carbonizing temperature has a direct bearing on the volatile matter in the coke. As mentioned, an appreciable difference in the volatile matter in samples of coke taken from the top of a charge and the whole charge, as would be expected, was previously found. This I have also experienced, even where higher top temperatures—viz., 1000° C.—were in vogue. The figure of 1·3% obtained at Croydon is lower than I have obtained even when working with a top temperature of 1000° C., and would therefore seem to require some explanation. It is understood, of course, that different methods of estimation give widely different results, but it is assumed that the Fuel Research Board method was used in all cases at Croydon.

Coke.

Although the question of the moisture in the coke may have no technical significance so far as the test is concerned, in view of its practical importance the inclusion of this figure would have been an advantage. Also the fact that coke from chamber ovens is notoriously dense might have warranted some notice of its reactivity. Perhaps Prof. Cobb will enlighten us and give us some information as to the suitability of chamber oven coke for general domestic purposes. This is very important, and engineers who are considering chamber oven installations to-day are very much concerned about the coke question.

Table IX. is extremely interesting as showing how the heat supplied to the setting is accounted for. The efficiency of 37·4% is admittedly low, due to the high efficiency of recuperation. The low temperature of 573° C. for the waste gases at the inlet to waste-heat boiler raises the question as to the economic soundness of installing a boiler to work under such conditions. Also the loss due to the quenching of hot coke from the chambers is emphasized, and it is observed that the loss of sensible heat in the coke is estimated at 45% of the total heat passed into the chambers, or a loss of nearly double the amount of heat actually absorbed from the waste gases in raising steam in the waste-heat boiler. Although perhaps the question (being an engineering one) does not arise in this report, I should like to know the reason for the recovery of 5·5 therms from the waste gases and not the 9·5 therms sensible heat from the coke.

It would be a matter of interest to know what type and make of pyrometer was used in taking the combustion chamber temperatures, as considerable divergence has been noted in readings by different instruments.

I would like to ask if the " Connersville " meter used was tested. It is our practice to test even the more accurate wet station meter used immediately before and again at the termination of a carbonizing test. Also, how was the 2·0 B.Th.U. correction for the calorific value of collected samples of gas arrived at? To me, it would seem to be an ingenious method of slightly increasing the therms per ton.

The method of estimating the " coke made " figure by weighing 72 individual charges and taking the average weight as that of the total of 1888 charges may account for the abnormally high figure of 13·9 cwt. of coke per ton of coal carbonized. To weigh something under 4% of the coke produced during the test does not seem to me to be " good enough " for a Research Report. To ensure the greatest possible accuracy we always believe in weighing everything—not only coal into a plant but also coke produced by the plant.

The quantity and temperature of " hot liquor " sprayed in offtakes and mains are important and might have been definitely stated, as both are of vital importance to the working of the plant. To keep free from pitch deposits figures have been stated which vary widely, and I shall be pleased if Prof. Cobb would give us the Croydon figures in gallons of liquor per ton of coal carbonized, and also the temperature of the circulated liquor.

Mr. J. S. Thorman (Gas Light and Coke Company): I wish to add my congratulations to the Research Committee on the very able investigation of the working of intermittent vertical chambers at Croydon carried out by Dr. Dent and his Research Staff. The data obtained, which is so clearly and concisely presented in this paper, cannot fail to prove a valuable work of reference.

Temperature in Intermittent Chambers.

Temperatures must be adjusted according to the amount of blue gas required, and steam used in its production, for a given calorific value of the mixed gas produced. At Croydon a gas of 550 B.Th.U. is required, which is obtained by steaming to the extent of 3·27% by weight of coals carbonized. With such comparatively low steaming, a moderate temperature gives the efficient results in this test. In the production of gas of a lower calorific value of about 510 B.Th.U. the amount of steam required for the additional blue gas to reduce the calorific value has to be increased to 7%-8%. If the same carbonizing period and coal throughput is to be maintained, the temperatures have to be increased considerably to obtain the same efficiency—in other words, a higher quality gas can be produced at a lower temperature.

Reference is made to the paper on intermittent verticals at Southall, as to producing a similar quality gas as at Croydon at considerably higher temperatures, and I take this opportunity of pointing out that the conditions at Southall were set for making a lower-quality gas, and that the test referred to of producing a higher-quality gas with lower steaming for inclusion in the paper was made at existing temperatures and avoiding the time taken in making rather an extensive modification. Referring again to the Croydon test, the temperatures were 875° top and 1300° C. bottom and the thermal yield per ton 73·63. These temperatures are stated to be 70° C. higher at the top and 40° C. higher at the bottom than those previously employed. On reference to Mr. Grogono's paper, I find that the average temperatures for twelve months were 805° C. and 1262° C. with a thermal yield of 74·51; but during the last four months (of the period referred to in Mr. Grogono's paper) the average top and bottom temperatures were 802° C. and 1298° C. with a thermal yield of 75·83. Comparing the temperatures of this test with those of the last four months' working dealt with in Mr. Grogono's paper, it will be seen that the top temperatures have been increased by 73° C. and the bottom by 8° C., and the increase in thermal yield was 2·8 therms. Is this increase in thermal yield attributed solely to the rise in top temperatures of 73° C. since the bottom increase of 8° C. is negligible?

It would be interesting to know how the temperatures fell off from the bottom to the top of the chambers, and how far up the chambers a temperature over 1000° C. was maintained, as the record of the top temperature only does not indicate this. The temperature drop between each of the five passes would be interesting. I should be interested to know whether any investigation had been carried out on admitting steam before carbonization was complete—for instance, at the 9th hour, and its effect on the thermal yield and the quality of coke.

The volatile matter left in the coke at 1·3% shows considerable reduction on the figures given by Mr. Grogono. Were any tests made to ascertain the reactivity and ignitability of the coke made during the test period as compared with that from lower temperatures? It would be interesting to know the number of coal gas therms and water gas therms making a total of 78·63 therms. I have calculated these approximately from the analysis of the gas and find them to be 73 therms coal gas and 5·6 therms water gas; also that the calorific value of the coal gas was 585 B.Th.U. and the water gas 300 B.Th.U. I should be glad of confirmation of these figures as they have an important bearing on carbonization in vertical chambers.

Coals and Thermal Leakage.

From my experience, first-class Durham coals of a similar ash and volatile content as recorded in the test would give a yield of 75 therms on a test plant; to obtain 73 coal gas therms in actual carbonizing in intermittent verticals is excellent working, and confirms the loss of 1·6 therms calculated from the carbon balance returned in the paper. Such a low thermal leakage is less than that to be expected in the best horizontal practice in which 2½ therms less is considered good practice. The attainment of such a low thermal loss is worthy of sincere congratulation.

There is no reference in the paper to benzole yield. In view of the lucrative market for benzole, information as to its yield, and particularly its quality, would be of value. The nitrogen content of the gas made during the test is extraordinarily low, which says much for the quality, design, and maintenance of the chambers—that after three years' service such excellent working is being maintained.

Mr. Arthur H. Lymn: It is with peculiar pleasure that I have perused this report, as I have taken a very active part in the pioneering of intermittent vertical chambers in this country, and am privileged to direct a Company constructing a similar type of plant to that dealt with therein. I refer to " C.O.L." intermittent vertical chambers. I could have wished that this investigation had taken place on one of the latter type of plants, but as they are so similar in general design (though different in detail)

I welcome very heartily the findings of the Committee, as they will form a *vade mecum* for this type of plant for a long time. I should like to take this opportunity of congratulating the Committee on the thorough manner in which they have carried out this investigation, and would not fail to add a meed of appreciation of the work done by the contractors in building the plant in question. There is another reason for appreciating this report in that it confirms, almost in their entirety, all the results which were reported by Mr. N. J. Bowater in his paper given before the Institute of Fuel in November, 1927, also at the Gas Conference at Birmingham in February, 1928. That report described a practical test carried out 5½ years ago on a "C.O.L." type plant several years old jointly by two officials of the Gas Light and Coke Company, and two officials of the "C.O.L." concern.

The test was on Londonderry coal (run-of-mine), and the main features of the results were as follows:

Moisture and ash in coal	9·68%
Calorific value of gas made	537 B.Th.U./c.ft.
Volume of gas made per ton	15,480 c.ft.
Therms " " "	83·2
Dry coke to producers as percentage of coal carbonized	13·5%

This paper was given five years ago, and at that time the results met with considerable scepticism—indeed, I think that the constructors of the Croydon plant did not entirely accept them. It is therefore particularly gratifying that the Research Committee has now entirely confirmed these, although, if anything, the results on that test were slightly better than those shown on the Croydon plant. In the intervening period, other articles have appeared concerning that type of plant, the results of which are also confirmed by this report. I have in mind more particularly the paper by Mr. Mills before the Southern Association of Gas Engineers reporting results on the Flathouse tests, although in this case a somewhat inferior coal was used when compared with that used in some of the tests in the report.

Temperature Difference.

It is interesting to note that the difference in temperature between the bottom and the top combustion flues is 425°. This difference appears to be decidedly on the high side considering the modest taper of the chambers. The remainder of the figures on that page are excellent and call for little comment.

The importance of temperature upon gas yield is noted. It has been found in practice that a certain critical temperature for each coal at the top as well as at the bottom of the chambers is requisite for optimum results. For example, it was found that second-class Durham coal, such as was carbonized at Flathouse during the test described by Mr. Mills, required 990° C. or over at the top and 1290° C. or over at the bottom. Lower temperatures may, of course, be employed with equal gas yields if the carbonizing period and steaming period is prolonged. It is also interesting to see that the plant was self-supporting in the matter of steam supply. Another plant of generally similar type with outside producers, for which I have been responsible, gives an excess of steam which is delivered to the works for other purposes. The percentage decomposition at Croydon almost exactly accords with claims which have frequently been made public and, I believe, viewed with scepticism.

Mr. Carmichael referred to the low temperature of the waste gases and consequently low recovery of steam at the Croydon plant, and mentioned the low thermal efficiency thereof. He compared it with the much higher temperature of gases leaving the chambers (and consequently higher steam recovery) in his plant at Flathouse.

It should be explained that the reason for the higher figures at Flathouse was that the recuperators for those chambers had to be built in to the steelwork of an older plant and consequently they had to be made considerably smaller than usual. It is in any case largely a local question as to whether it pays to make more or less steam in this way.

The loss of heat incurred on discharging coke at a high temperature is referred to, and it is later pointed out that the sensible heat of the coke discharged at 900° C. would be 9·5 therms per ton of coal carbonized. Although it is claimed that this loss of sensible heat is avoided in continuous vertical retorts by internal quenching, I feel that this does not quite present a true picture, since, if this 9·5 therms per ton of coal carbonized were utilized in the carbonizing process the fuel consumption in the form of coke to producers given as 37·69 therms would be reduced to 28·15 therms—a figure which I believe is much lower than has ever been obtained in practice. On the other hand, with efficient dry cooling plant over 9 therms are recovered, thus rendering the combination of intermittent vertical chambers with dry cooling plant probably the most thermally efficient method of carbonization.

I have a suggestion to make to the Research Committee in regard to another investigation. The information given on the subject of self-contained producers is decidedly interesting, and shows for that type of producer high efficiency. It may be known to some of those present that for many years I have devoted special attention to gas producer plants, particularly those yielding cool and clean gas. My Company has actually constructed in several instances the three combinations:

(A) Outside gas producers of the most modern mechanical type supplying cool clean gas to the vertical chambers.

(B) Outside hot gas step-grate producers.

(C) Self-contained producers.

I would suggest to the Committee that it would be a very interesting investigation if similar work to that shown in the present paper were carried out in reference to the first of these combinations, and possibly the second also. The question of outside producers has been the subject of much controversy. They are very widely used indeed on the Continent, and have many advantages. Perhaps the Committee will think this matter over, and I place myself most gladly at their disposal to assist in any such investigations to the utmost of my power.

Dr. S. Pexton (Gas Light and Coke Company): This Report discusses at some length the determination of carbon and hydrogen leakages from the retorts into the combustion chambers by utilizing the waste-heat boiler as a meter for measuring the volume of waste gases leaving the retort setting. When the leakage of gas is small, as at Croydon, the calculated quantity of carbon passing through the waste-heat boiler is so little different from the quantity of carbon gasified in the producers that possible errors in the large number of measurements involved are greater than the quantity of carbon leakage to be determined. This is clearly dealt with in the Report. It would have been instructive if the summary of the possible errors had also included the effect of using different observers' values for the specific heat of carbon dioxide.

It is possible, without resort to the waste-heat boiler method, to determine with a fair degree of accuracy, the thermal leakage of coal gas, excluding any water gas leakage. The method, which is extremely simple, can be included in works' routine tests. It consists in taking an average sample of producer gas, burning it with excess air in contact with platinum, and analyzing the products of combustion. An average sample of waste gas containing air is similarly passed over heated platinum to ensure that it is completely burnt. The products of combustion are analyzed in the same manner as the products of combustion of the producer gas. It is preferable to eliminate the sulphur constituents from each gas sample before analysis. The apparatus designed by Prof. Haldane is eminently suitable for the analyses. It is no more expensive than the Orsat apparatus which is not suitable. The analyses of the products of combustion in both cases are corrected to an air-free basis and the calculation of the thermal leakage of coal gas is made as follows.

A Method for Intermittent Retorts.

The method is intended particularly for intermittent retorts in which case the bulk of the leakage occurs at an early stage in the carbonization when the composition of the crude gas leaking may be taken as:

CO_2	3
C_nH_m	5
CO	9
H_2	40
CH_4	40
N_2	1
H_2S	1
NH_3	1
	100 c.ft.
Tar	1·6 lbs., containing 87% C and 6% H_2 by weight
Calorific values per c.ft. of gas—	
Gas	= 680 B.Th.U.
Associated tar	= 250 "

The air-free products of combustion of this crude coal gas including tar contain 14% of carbon dioxide, and their volume is 8 times that of the crude coal gas. Assume for the moment that the weight of carbon burnt in the producers is 250 lbs. per ton of coal carbonized. If the air-free products of combustion of the producer gas contain 20·9% of carbon dioxide, then their volume (c.ft. saturated and

at 60° F. and 30 in. pressure) will be 38,500 c.ft. per ton of coal carbonized.

The following relation therefore holds:

$$x = 38{,}500\,\frac{20{\cdot}9 - C}{C - 14{\cdot}0}$$

The volume of coal gas leakage is $\frac{x}{8}$, and the thermal leakage of coal gas, including tar, is $\frac{930\,x}{800{,}000}$ therms. The thermal loss of purified gas (excluding tar, &c.) is $\frac{680\,x}{800{,}000}$ therms. Numerical values for these expressions are tabulated below.

Carbon Dioxide in Air-Free Completely Burnt Waste Gases Leaving Retort Setting C %.	Therms per 250 Lbs. of Carbon Burnt in Producers.	
	Leakage of Coal Gas, including Tar.	Loss of Purified Coal Gas (Excluding Tar, &c.)
20·9	*Nil*	*Nil*
20·6	2·2	1·6
20·4	3·5	2·6
20·2	5·1	3·7
20·0	6·7	4·9
19·8	8·5	6·2
19·6	10·4	7·6
19·4	12·4	9·1
19·2	14·6	10·7
19·0	17·0	12·4

These quantities refer to the 250 lbs. of carbon burnt in the producers per ton of coal carbonized, and they should be adjusted in direct proportion to suit the fuel consumption of the particular installation examined. For example if the carbon burnt in the producers is 200 lbs. per ton of coal carbonized, and if the air-free analyses of the products of combustion of the producer gas and of the waste gas leaving the retort setting are 20·9 and 19·8 respectively, then the leakages adjusted from the last two columns of the Table are $\frac{200}{250} \times 8{\cdot}5$ and $\frac{200}{250} \times 6{\cdot}2$, or 6·8 and 5 therms per ton of coal.

Inspection of the equation will show that if the CO_2 in the air-free products of combustion of the producer gas is less than 20·9—*e.g.*, 20·4—the figures for leakage in the Table must be reduced in the proportion of $\frac{(20{\cdot}4 - C)}{(20{\cdot}9 - C)}$

While this method is reasonably accurate for intermittent retorts of all types it should only be applied with caution to continuous vertical retorts, bearing in mind that the composition of the coal gas, apart from the presence of water gas, differs widely at different heights up the retort. In fact, the probability is that the coal gas leakage consists of poorer gas than the average quantity of gas made.

Hydrogen Diffusion.

In connection with this method for determining coal gas leakage, there is one question which may arise in your minds—viz., does hydrogen diffuse through the retort walls and, if so, to what extent? Any hydrogen diffusion will, of course, be included in the determined leakage figure, and because of the low calorific value of hydrogen its loss is less serious than the leakage of hydrogen which will be accompanied by the leakage of rich coal gas constituents as well. This question requires an investigation on large scale plant by a method such as follows.

Suppose a charge of coke is allowed to remain in a retort until the evolution of gas, particularly hydrogen, is complete, and then a measured quantity of steam is admitted to the retort. The products of combustion of the water gas formed should have the same analysis as the products of combustion of the completely carbonized coke in the retort so long as no diffusion of hydrogen through the retort walls takes place. Further, any diffusion can be measured in this way. We have carried out preliminary experiments of this type on the intermittent vertical retorts at Southall, and the indications are that the amount of hydrogen diffusion is small compared with the normal leakage of hydrogen met in practice. Further work along these lines is required before a final pronouncement can be made on the subject.

Prof. J. W. Cobb: I am not going to offer any technical comments on this report or on the contributions to the discussion which have been made, because that lies in Dr. Dent's hands. The Joint Research Committee had considerable hesitation about undertaking this particular piece of work. It might very reasonably be argued that previous tests have been made on a similar plant—and good tests too—and that all that could be expected in our report would be something that was exceedingly likely to be a simple confirmation of results previously obtained. There were other people who urged various arguments against that point of view, with which I need not deal in any detail. There was another difficulty in connection with this report, and it was that a section of the research workers of the Committee was already engaged upon the consideration of results obtained in the investigation of the back-run water gas process. It was, as you will realize on studying the report, really very much more than an investigation of the back-run water gas process; it was also a searching investigation into the water gas process itself.

The question arose as to whether there would be time for this meeting to do justice to that study of water gas and to the tests which had been carried out on the chambers also, but the right decision, I think you will agree, was made that the water gas report was to be completed satisfactorily, that it was no use putting that forward, considering the amount of labour and thought that had been given to it, in a half-finished condition or without full consideration of what the meaning of the different results might be. The question was whether we could complete that in time—and when I say "we" I really mean Dr. Dent and his assistants. We wanted both to be done, and they have been done; but you will readily realize that it has only been possible to bring out both reports at this meeting, and particularly the 32nd Report on intermittent vertical chambers, by exceptionally hard work on the part of Dr. Dent and his assistants, to whom I should like to bear testimony from first-hand knowledge, and for which I am quite certain you will take my word even if it were not obvious from the contents of the report how much and what intense work has been put into its preparation.

The 32nd Report had to be prepared in a hurry, and there again I felt a little trepidation; but I may say that that trepidation and uncertainty about the report disappeared entirely when I read Dr. Dent's draft of what he proposed to put forward. It was obvious that it was a report that was going to be very well worth while putting forward in the name of the Joint Research Committee, and that he and his assistants had been able to get a great deal out of the investigation that they had undertaken, and that they had managed to put it forward in the form of a report which would presumably be useful. That presumption of usefulness, I am pleased to find, has been completely justified by the testimony which has been forthcoming. In the first place it is plain from what Mr. Richards said and from what Mr. Lymm said, that this was not only the sort of report that might make interesting reading or might come in useful to somebody who had to consider this kind of thing in a general kind of way, but it was of the quality which would make it directly useful to the actual designers and constructors of plant. Mr. Carmichael, Mr. Grogono, and Dr. Pexton have also made it clear from the point of view of the practising gas engineer and chemist who is keen on getting the very best out of the plant, that this report has again its sphere of usefulness so far as they are concerned. Perhaps no higher testimony to the quality of the report and to its direct practical value, apart from its undoubted scientific value, could be forthcoming; and it is very gratifying to the Joint Research Committee that such testimony should be forthcoming at an important meeting of this kind. I might simply add that what I have had to say about the rush in which this report was prepared will perhaps explain to Mr. Carmichael that there are a few things to which he referred which might have appeared in the report if there had been leisure to bring everything together. No doubt some points have been omitted; and Dr. Dent, I am sure, will be very pleased to deal with them so far as he can in the written reply which he has promised to make.

23rd Report of the Refractory Materials Joint Sub-Committee

Dr. H. G. COLMAN: In introducing the 23rd Report of the Refractory Materials Joint Committee, I do not propose to deal with the technical portion of the report. I do wish, however, to express on behalf of the Committee, and personally for myself, our deep appreciation of hard and successful work carried out during a year of considerable difficulty. It is with regard to those difficulties that I wish to speak for a few minutes. As you know from statements made in previous years by myself and by former Chairmen of this Committee, the funds available for carrying out the research work by the British Refractories Research Association have always been very limited; and during the late critical period these have fallen considerably. During the past year the lessened funds rendered necessary a reduction in the research staff and in the salaries paid to those who remained, as well as a minimum expenditure on equipment. During the year the Department of Scientific and Industrial Research gave notice that the grant hitherto made to the Association from the Department's fund could not be continued after June 30 unless the amount subscribed by manufacturers and users of refractory goods were to be largely increased. Such reduction in income, added to the continued falling off in subscriptions, would probably have involved the closing-down of the work.

SUCCESS OF SPECIAL APPEAL.

In July last, therefore, a special appeal for increased support was issued to manufacturers and users; and I am pleased to say that as the result of this appeal increased and additional subscriptions have been promised bringing the amount from manufacturers and users rather over the minimum fixed by the Department of Scientific and Industrial Research, below which no grant could be made by them. In view of this fact the Department have offered, and the Council of the British Refractories Research Association have accepted, a grant in aid of the Association on the £ for £ basis on the subscription income from manufacturers and users for each £ over the first £3000, subject to a maximum grant of £1800. To this successful result the Gas Industry has been a very large contributor, the total promises by the Institution from its Research Fund and from individual gas undertakings having been increased from about £530 to £2240. I wish here again to express the gratitude of the Sub-Committee and of the Council of the Research Association for this generous response, and our hearty thanks to the Institution, to the National Gas Council, and to each of the sixty-seven gas undertakings who have promised individual subscriptions.

The promised contributions from manufacturers and users other than the Gas Industry amounts to £3400, so that with the grant from the Department of Scientific and Industrial Research the anticipated income for the year is over £7000, or nearly double that hitherto available. With this increased income it is now possible both to increase the extent of the work in the matters already being investigated for the Gas Industry, and also to put in hand additional researches which have hitherto been held back owing to lack of funds; and it is the hope and expectation of the Committee that the progress of the work will be such as will amply repay the increased expenditure.

Mr. F. WEST: Considering the report from a technical standpoint one feels that very good progress has been made by the research workers during the past year in many problems of interest not only to the Gas Industry, but to all manufacturers and users of refractories. It is quite evident that, in recent years, the publication of results of research work on various aspects of refractory materials and the knowledge which has been gained from these publications have resulted in a wider understanding of the use and manufacture, which is certainly to the advantage of all concerned.

This keener appreciation of the value of such work and extension of the knowledge of refractories is enabling a more intimate fusion of ideas to take place between the producer and consumer regarding the necessity for combining the practical conditions of usage of refractory materials.

WORK OF VITAL IMPORTANCE.

Much of the research work carried out during the past year is of vital importance to the Gas Industry, in that these investigations are throwing definite light on several problems connected with retort refractory materials.

The work on permeability, while primarily indicating that the amount of gas leakage through retort material at working temperatures is comparatively small, is also leading to a possible means of controlling the liability of retort materials to "flaking" and "erosion" during their working life.

Another point of interest revealed by permeability investigations is the fact that diatomite material has a remarkably high resistance to gas penetration as well as to heat penetration. In a similar manner the study of the disintegration effect of carbon monoxide on certain types of refractories, while indicating to manufacturers weaknesses in their products, also illustrates to the gas engineer the mechanism of one contributory factor to the "flaking" of retorts.

Problems of practical application such as "Hot-patching and Spraying of Retorts" are being investigated with a considerable measure of success in spite of the many difficulties. The investigations have indicated the dangers that attend the hot spraying and patching with water mixtures, and it definitely appears that progress in the right direction will be made by using dry powders preheated by passing through a high-temperature flame. Repairs by these methods, however carefully carried out, are, at the best, only temporary expedients.

It is gratifying to note that work on the foregoing problems is being continued, particularly in relation to conditions existing in modern carbonizing plants, also that a continuance of the study of the factors influencing retort life is being made by systematic examination of retorts after working and recording of results thus obtained. There are, however, in addition to the list of investigations in hand, I suggest, two further problems which might be investigated with advantage to the Gas Industry. They are:

1. The swelling of various coals in relation to grading size, and, when plastic, their penetrative effects on the refractory material.
2. Some attempt at the definition of the expansion stresses in retort structures, especially with reference to shape of the structure, should be made in order to better appreciate the liability of the retort to cracking and spalling at certain positions. This would also necessitate the exploration of the temperature conditions existing on the inside face of the retort under varying conditions, especially in relation to the formation of carbon or scurf in the retorts and the extent of heat changes during the burning off of the carbon. I believe this is a very important point and may be largely responsible for much of the spalling which takes place on silica refractories.

These problems are of direct practical value to the Gas Industry, and definite knowledge regarding these factors would in all probability be the means of resulting in considerable increase in efficiency of working and saving in structural repairs.

HOT-PATCHING.

Mr. A. A. N. CARPENTER: I have been very much interested in that part of the Refractories Report dealing with hot-patching. I think it will be generally agreed that in the ordinary way very little hot-patching of continuous vertical retorts is required, but special circumstances may arise where this has to be done; and with your permission I will give you an experience of mine in this connection. About three years ago at Kensal Green some continuous vertical retorts were built with a special material for about 3 ft. in that part of the retort liable to spalling. Unfortunately, the experiment was not a success. The material did not spall, as the term is usually understood, but after a time the ends of the bonding blocks came clear away to a depth of 1½ in., the point of fracture being the line of the joint groove. The retort walls were so roughened by this breaking away that the coal travel was very uneven; and it began to look as if the retorts would have to be let down for repair. A large number of patching cements were experimented with, and in the end a cement was found which was entirely suitable, and we were able to mend the bad places while hot. The retorts have been kept working in good order for more than 1100 days and

are still at work. I mention this because it is a practical example of the value of a suitable fire cement combined with a good method of application.

Mr. F. FIRTH (Leeds Gas Department): I wish to congratulate the authors on their excellent contributions, and I assure them that the Gas Industry take careful note of what is contained in the papers given to us by the British Refractories Research Association.

At the research meeting last year I was interested in Mr. Rhead's contribution to the discussion on the refractory communications. He referred to the application of patching cements in a dry state; and I am pleased to see that preliminary experiments on these lines have been carried out. I trust the experimenters will soon be able to evolve a method for application in practice.

The authors emphasize the bad effects of the sudden chilling on the retort surface which is inevitable when any water is used with the cement, and the chilling effect is very pronounced with any method of spraying. In his Presidential Address to the Institution in 1930 Mr. Shapley referred to the use of spraying with old horizontal retorts as an experiment for prolonging their usual life, and though this is undoubtedly useful in reducing discharging difficulties we were also led to believe that spraying was of material assistance in preventing loss of gas through the retort walls. Later investigation has shown that any such tightening effect is of very small magnitude and would not justify the use of spraying for that purpose alone. That, together with the inevitable severe chilling, makes us at Leeds very cautious in using wet spraying methods.

The use of cements in the dry state is, to my mind, worthy of intensive investigation; and I trust the authors will be given the opportunity to go ahead with the work.

It may interest the authors, and show them how their continued efforts are appreciated, if I state that when they published their permeability figures last year we immediately applied them to our retorts at Leeds. Suitable assumptions were made in the calculations, and we felt satisfied that leakage due to permeability was a very small quantity. As an example for a through 20 ft. 6 in. horizontal retort it was calculated that the loss due to permeability was of the order of 8 c.ft. per 24 hours for $\frac{1}{10}$ in. W.G. differential pressure within the retorts. We then attempted to survey the pressure conditions existing during carbonization on the horizontal retort walls. It was found to be a very difficult matter to obtain precise measurements; but I doubt whether the pressure exceeds a few hundredths provided careful control is exercised.

I note that in the example given by the authors they assume a maximum differential pressure of 0·35 in. at the uppermost zone of a vertical retort. They also give the opinion that the pressures in the free space of horizontal retorts are greater than those in vertical retorts. This is of practical importance, because I am doubtful of the existence of such high pressures within horizontal retorts provided satisfactory pressure control is exercised during carbonization.

Mr. T. ALLEN (Gibbons Bros., Ltd., Dudley): I should like to express my sympathy with the work that Mr. Green has carried out. We have carried out considerable experiments at our own works on many different mixtures, applying them in the plastic state both by gun and otherwise; but unfortunately we have found nothing entirely satisfactory, although the experiments were undoubtedly interesting. We did not carry out any experiments, however, with the spray type of machine. There is just one point in the report that I have particularly noticed—the temperature used by Mr. Green was 1350° C. All our tests were carried out at temperatures which we regarded as normal inside a retort—namely, about 1150° C. It therefore occurs to me to ask why Mr. Green and his staff decided to test at so high a temperature, because I think it is obvious that entirely different results would follow at the lower temperature. At any rate, it would appear to be so, as far as our experiments went; and I suggest that Mr. Green should consider it advisable, in continuing these tests with a blow pipe, to adopt a lower temperature at the surface to which he proposes to apply the cement, having regard to the somewhat unsatisfactory results not only in Mr. Green's experiments but also in our own.

We have endeavoured to tackle this problem rather at the source, from the manufacturing point of view, by paying particular attention to the type of quartzite used, the very important question of grinding, and also that of moulding. This has undoubtedly shown us that beneficial results have occurred, and I am able to emphasize this point more particularly because we were able to compare British material with some of the best German types of material particularly in coke oven work. I also note that experiments are to be continued in permeability. I think it was four years ago during one of my visits to Germany that the question of porosity and permeability was brought forward in a very important manner; and that is one of the reasons why I brought it before our Committee some two years ago. We shall look forward with very great interest to futher tests in this direction. We have carried out certain experiments of the kind ourselves which have necessitated scrapping some thousands of pounds worth of plant, particularly the grinding part of it, but I am glad we did it because I see now that by altering our grinding methods we have undoubtedly produced a material which gives a low porosity with improvement in the permeability and, what is perhaps more important, an improved abrasiveness of the goods when finished. We shall look forward to further information from our technical friends; and speaking as a manufacturer I do feel most indebted to them, because they have given us the key to the carrying-out of these experiments for improving materials which otherwise it is very questionable whether we should have got as far as we have in the perfection of their manufacture.

WET SPRAYING AND DRY SPRAYING.

Mr. T. F. E. RHEAD: I do not know whether the meeting appreciates the real hard work, and the persuasive efforts of our Chairman, Dr. Colman, in so successfully getting the extra money together. I do not think we should have got that money if we had not had a man with the personality and of the persuasive type of Dr. Colman. While I am throwing bouquets about I should also like to say how thoroughly we appreciate the ready grasp that Mr. Green has of our problems in the gas-works. To think that in about two years he has become an expert, and can tell many of us in the gas-works more about the subject than we know ourselves, is a very fine tribute to Mr. Green, and shows that we have really a thoroughly practical man who is also an academic man at the head of our research staff. I am very glad that he has thrown over the idea of the wet spray. The wet spray seems to be successful according to the amount of faith you have in it. At some of our works in Birmingham they are quite sure it is a good thing, but at others we are just as convinced that it is no use at all; I am one of the latter.

I was looking up some notes which I made about four years ago which included a few suggestions with regard to this matter. Some of them may be new and some may not, but I thought it might be of interest to refractory material chemists to examine them again. One of them was the use of the oxy-acetylene flame to spray material through on to the retort. That is something on the lines along which Mr. Green is working, although I believe he is using oxy-coal gas or air gas. Another thought was whether we could use some compound akin to Thermit for this purpose, and I put down four years ago also that we should try powdered metallic silicon injected through a jet of oxygen, or a mixture of chromium trioxide and alumina, or aluminium or silicon. These are probably highly academic ideas; but they struck me that they might help to put the refractory in its right place. Another idea of mine at that time was whether we could deposit silica from silicon-hydride and pass that down into the holes. I know you will say that these are desperately academic, but they may have the germ of something in them. At any rate, I put them forward for what they are worth.

We have also tried spraying dry powders on to the bricks, but we have not got any further than Mr. Green. We came up against the same trouble—namely, an extremely porous and spongy type of joint unless an excessive amount of flux is used to make it more coherent. As regards permeability, I entirely agree with the finding in the report that there is not much in this from the thermal loss point of view, but there is a great deal in it from the point of view of the diffusion of various metallic vapours, and so on, into the brick iteslf.

MR. GREEN'S REPLY.

Mr. GREEN, replying to the discussion, said: I suppose we are always friends when we get bouquets; and consequently I must say the right thing in reply to this discussion. Everyone has expressed their satisfaction with the work that has been done, but I may confess that I have been " touching wood " for three weeks as to whether I should be told something very different. However, I should like to thank Mr. Frank West for his interesting comments. He touches on a very important point when he refers to the swelling of coals in vertical retorts. We know that a lot of the troubles which are part and parcel of vertical retort working arise in the zone where we get a fair amount of swelling; and we know there is a definite connection between that swelling and the temperature. But how far that—apart from the dislocation of the brickwork which can be caused by the immense pressure set up—has another effect in promoting actual adherence and tenacity of the skirt, I am not able to say. There is no

doubt, however, that the skirt is most tenacious at the places where the swelling of the coal is likely to take place.

As far as expansion stresses are concerned, here again we have a programme of activity which would probably occupy a staff of ten of us " mooching " about the country having a good time and measuring up this, that, and the other for about two years before we could arrive at a good conclusion. Nevertheless, we have actually measured up quite a number of retorts. Incidentally, may I remind you that I worked for Mr. West's firm and for West's Gas Improvement Company, and actually measured quite a number of retorts, which led me to the conclusion that there may be certain stresses set up in certain zones in the retort. From the measurements that were made the temperatures of the carbonizing face can be computed, but I am afraid our computations of temperature are invariably wrong. [Laughter.] I say this advisedly, because we can use the normal temperature equations and can elaborate Fourier's theory, and can make K constant or vary it with temperature, as the case may be; but one never gets the real temperature of the carbonizing face. The temperature inside a retort is exceptionally difficult to visualize, because in some cases the coal charge just touches the face and in other places it does not; and this would considerably alter, from my way of thinking, the actual temperature of the face, and, therefore, the factors that would be dependent upon that temperature.

I should like to thank Mr. Carpenter for his interesting contribution to the discussion, which will be rendered more interesting when I know the nature of the cement he uses.

Again, with regard to Mr. Firth and the application of the dry spray, I think the work that we are doing proves that we consider that is the actual correct solution of the problem; and I thank him very much for his interesting experiences.

Again, that stalwart Mr. Allen is sympathetic in our work of hot-patching. It is surprising when one has had indigestion how one sympathizes with somebody else who has got it, and apparently Mr. Allen thinks that we have got it. [Laughter.] But I am not at all certain that we have, because I think we are beginning to see something that is not indigestion in the study of hot-patching; and I believe that in a year or so, if you will be patient with us, we shall have a very definite conclusion on the whole business.

May I say that our surfaces were not all at 1350° C. We have gone up from 900° to 1350° C., and if we had quoted in this report every test we had made I am afraid that the Secretary of the Institution would have been very wrath at the number of pages required. Therefore, we have had to cut out a great deal; but even in the report it is mentioned that we have done work at 1250° C. I am glad of Mr. Allen's interest in permeability. It is one of those subjects which we do not quite know how the general public will take, and yet we believe it has a very definite bearing on industrial considerations.

I thank Mr. Rhead for his kind remarks, but I would remind him that I am more than two years old in the Gas Industry. I have been doing jobs for the Gas Industry for eight or nine years on the research side with refractory material, and therefore I cannot take the credit for having become a genius so quickly. In connection with the application of cements, may I thank Mr. Rhead for the help he gave us in the first place with respect to our work on permeability, and in the discussion last year he gave us many ideas on hot-patching. We had actually tried the sprays we had mentioned in the report before he said anything last year; nevertheless he gave us many interesting ideas. Now to-day he touches on some things that we have looked upon as almost sacred to ourselves. We thought we had hit upon a remarkably brilliant idea, but up comes Mr. Rhead and gives it all to the meeting with the aplomb of a genius himself. [Laughter.]

New Members of the Institution

On Wednesday, Nov. 2, the following were elected to the various classes of membership of the Institution:

Membership.

Hollis, Harry Hedley, Managing Director, Oxley Engineering Company, Ltd., Hunslet, Leeds.

Mathieson, William, Junior, Managing Director, Wilsons & Mathiesons, Ltd., Scotch Foundry, Armley, Leeds.

Mitchell, John, Engineer and General Manager, Southgate and District Gas Company.

Associate Membership.

Anderson, Eric Charles, Technical Assistant, Ellesmere Port Urban District Council Gas Department.

Bell, Donald Slater, Junior Technical Assistant, Mossley Corporation Gas Department.

Benson, Donald, B.Sc., *Institution Diplomé in Gas Engineering, 1st Class,* 1932. Works Superintendent, Lum Street Works of the Bolton Corporation Gas Department.

Britton, Alfred Benjamin, Engineer and Manager, Hinckley Urban District Council Gas Department, Leicestershire.

Chilcott, John Aubrey, Head Chemist, Swansea Gas Light Company.

Dickenson, Alfred William, Assistant Chemist, Croydon Gas Company, Surrey.

Dow, James MacIntosh, Senior Chemist and Draughtsman, Perth Corporation Gas Department, Scotland.

Johns, William Henry Thomas, Technical Assistant, Cheltenham and District Gas Company.

Kelley, Arthur Frederick, B.Sc., Technical Assistant, Elswick Works of the Newcastle-upon-Tyne and Gateshead Gas Company.

Kerley, George Edwin, Laboratory Assistant, Croydon Gas Company.

Kirk, William, Assistant Manager, Polmont District Gas Company, Ltd.

Kirkwood, William Oliver, *Institution Diplomé in Gas Engineering, 1st Class,* 1932. Senior Chemist, Sunderland Gas Company.

Nicholson, Alan Hetherington, Engineering Assistant, Darlington Gas Department.

Peel, Alfred Ernest, Engineering Assistant, Stockton-on-Tees Corporation Gas Department.

Pennington, Charles William, Technical Assistant, Newbury Corporation Gas Department.

Plevin, William Ewart, B.Sc., Shift Engineer, Blackpool Corporation Gas Department.

Rowan, Thomas Arthur, Assistant Engineer and Manager, Dumbarton Corporation Gas Department.

Sturrock, Norman Collie, Technical Assistant, Greenock Corporation Gas Department.

Symon, Frank Goodall, Chief Assistant, Burgh of Motherwell and Wishaw Gas Department.

Wilkes, John Edward, Assistant Engineer, Hereford Corporation Gas Department.

Associateship.

Aitken, John Grant, Technical Assistant, Carlisle Corporation Gas Department.

Alley, Walter Henry, Manager, Westbury Gas and Coke Company, Ltd.

Bate, Frank Harold, B.Sc., Carbonizing Superintendent, City of Birmingham Gas Department.

Bingham, James Herbert, Technical Expert, George Glover & Co., Ltd., Chelsea, S.W. 3.

Birks, Cyril Douglas, Senior Partner, Messrs. Abbott, Birks, & Co., 113, Newington Causeway, S.E. 1.

Boyes, Harold Stanley, Assistant Engineer, Cheltenham and District Gas Company.

Bujnowski, Alexander, M.C., *Institution Diplomé in Gas Supply, 2nd Class,* 1932. Assistant to Industrial Superintendent, Glasgow Corporation Gas Department.

Cowie, Robert, Technical Assistant, Hawick Gas Company, Ltd.

Davies, David Stanley, Operator, Woodall-Duckham Companies, 150, Victoria Street, S.W. 1.

Hilliard, Richard Montagu, Acting Assistant Inspector, Gas Light and Coke Company, London, S.W. 1.

Napier, John Watson, Junior, B.Sc., Manager, Chemical Engineering Section, Newton Chambers & Co., Ltd., Sheffield.

Percival, George, Resident Works Superintendent, Fuel Research Station, River Way, East Greenwich, S.E. 10.

Planck, Colonel O. B. F., D.S.O., D.L., Local Director, Stewarts & Lloyds, Ltd., Birmingham.

Poulter, Lionel Charles Stevens, *Institution Diplomé in Gas Supply, 1st Class,* 1932. Industrial Representative, Gas Light and Coke Company.

Race, Joseph H., B.Sc., Engineer and Manager, Farnworth and Kearsley Gas Company.

British Road Tar Association

ADDRESS BY SIR DAVID MILNE-WATSON, LL.D., D.L., THE PRESIDENT,

At the Fifth Annual Meeting on Nov. 2

A year ago we met under the shadow of a grave national crisis. Although the general crisis has not yet passed, the situation appears to be under control, and there can be no doubt that the complete success of the War Loan Conversion operation stands out pre-eminent among the events which have lately turned the business world from deep depression to hopes that the worst has at last been passed. The Conversion has marked the restoration of the country's credit, but this credit can only be maintained by a rigid policy of meeting expenditure out of revenue; and if revenue is to be collected, industry must make profits. There can be no doubt, therefore, that not only must industry be relieved of some of the burden of taxation now imposed upon it, but also that expenditure must be reduced. Without relief of this kind, a great part of the benefit which we should reasonably expect to receive from the restoration of British credit is likely to be jeopardized.

The Price of Neglect.

Last year I urged that economy should not be confused with mere parsimony, and quoted the Prime Minister's plea that we should continue to spend, but to spend wisely. I asked that the long view should be taken; and while welcoming all possible and reasonable reductions in national expenditure, I urged that necessary work and necessary maintenance should not be lightly postponed, in order to effect an wholly illusory saving of public money. Once again I wish to draw attention to this matter. To neglect our great network of communications seems almost equivalent to announcing to the world that we do not ever expect to return to times of prosperity. In point of fact, to neglect our roads will save us no money at all. The price of neglect to-day will be heavy additional expenditure in the future. Writing as President of a body naturally interested in any legitimate economy, the National Federation of Property Owners and Ratepayers, Lord Hereford recently said: " I place very little faith in economies effected by a mere juggling of figures. True economy will only come about by thoroughgoing research into what I might call the ' first causes ' of public expenditure. It will be the duty of every ratepayer to see that the money saved is money that will not have to be spent twice or three times over a few years hence. Our road expenditure is heavy. Careful re-examination of our needs and our resources would, I feel sure, reveal ample opportunity for substantial savings; but there is a limit below which we cannot safely reduce road costs. Ratepayers in their own interests cannot afford to see the roads neglected. Nor is bare maintenance alone sufficient. Traffic is increasing year by year. Year by year our roads must grow *better*, if we are to maintain national efficiency."

I am in complete agreement with Lord Hereford, and I think I can safely go so far as to say that it is now generally admitted that we cannot cut expenditure on roads much further without impairing the efficiency of our highway system. In 1931, the combined revenue from motor taxation and petrol duty exceeded £57,000,000, representing an average tax of £26 per vehicle, and the user of the road is surely fully justified in insisting, not only upon proper maintenance and reasonable development of the great highways system of this country, but also upon the wise and economical expenditure of this immense revenue.

Vigorous action will, I hope, be taken to reduce the appalling loss of life in road accidents. Many factors enter into the safety of our roads, but there is one factor to which in the past, I think, too little attention has been paid, and that is the condition of the road itself.

Safe Roads Can be Made with Tar.

" I cannot," said a Member of Parliament during a Ministry of Transport debate in the House of Commons a few months ago, " recollect ever having heard of the responsibility which the Government and the local authorities have as regards safety on the roads. Each of the schemes for which the Ministry of Transport agrees to pay public money to the local authorities is regarded as an approved scheme, and the question I would like him to answer is this: Is his approval concerned solely with the finance of the scheme, or does his Department take into consideration the safety of the scheme from the point of view of road and pavement users?"

Safety, surely, is the prime necessity of any road. No matter how excellent it may be in other respects, it is essential that it should be safe for all ordinary traffic purposes.

It is our claim that, with scientific laying and the proper choice of materials, safe roads can be laid with tar. That claim is based, not only on the experience gained with ordinary traffic on ordinary roads, but also on the experience gained with motor racing. In the Isle of Man, to quote one example, motor-cycles were able to maintain average speeds of very nearly 80 m.p.h. without serious mishap, on ordinary tarmacadam roads.

This country was the pioneer of coal-mining, partly because of the great natural advantages which our coalfields possessed, and partly because British enterprise led the way in applying coal to the uses of mankind. An exhaustive analysis of the causes of the serious decline in the fortunes of the coal industry would be outside our scope to-day; but our country is very vitally concerned with the fortunes of that industry, and we as members of this Association must share that concern, since coal is the raw material from which our product is derived. From the raw material right through a wide range of products, we see competition between two great sources of energy—one of them our so-called greatest national asset, coal; the other an imported material, mineral oil.

Surely, it is the essence of wise economy that we spend our money wisely at home—that we make the fullest possible use of our own national raw materials and their products.

British Tar for British Roads.

We fully realize, however, that appeals to " Buy 100% British " must be backed up by actual demonstration that the products of British research and enterprise are worthy of consideration, not only because they are prepared in this country of materials wholly produced at home, but because they are best suited to their purpose.

We are to-day reviewing the fifth year of the work of our Association, engaged as it is upon the task of encouraging and developing the use of British tar on British roads, a matter of concern both to the road engineer and the road user. Again this year we have carried out demonstrations to show what our product can achieve in actual practice on the road, and in addition we have inaugurated a plan of the greatest importance both to ourselves and to our customers.

A Road Tar Research Committee.

The Association's proposals for co-operative research on road tar having received the sympathetic consideration of the Committee of the Privy Council for Scientific and Industrial Research, a Special Road Tar Research Committee has been appointed to supervise a general programme of research. This Committee consists of five representatives each of the Association and the Department of Scientific and Industrial Research. The work is being carried out at the Chemical Research Laboratory, Teddington, under the direction of Prof. G. T. Morgan, and the cost is being divided equally between the Department and the Association.

The benefits of research are obvious, and a progress report has recently been received which indicates that we may look forward through this work to the Association rendering a further service to the road industry of Great Britain.

International Road Tar Conference.

For the benefit of our own industry, and in a desire to co-operate to the fullest possible extent with those engaged in other countries in the same business as ourselves, we took the initiative in creating an International Road Tar Conference. This conference is now firmly established, and only a few weeks ago it was my privilege to preside at a plenary session of the conference held in London. The usefulness of this conference lies in the opportunity it affords for those engaged in the Road Tar Industry in different countries to exchange views and experiences, and thus encourage action and co-operation for the purpose of promoting the use of road tar in each country.

I want to lay great stress upon this side of our activities, which is directed primarily towards the improvement of our product, because I feel it is the very natural and very proper counterpart to our advertising and propaganda work. We want our customers to appreciate that the funds which we have placed at the disposal of our Association

are being used towards an end that must commend itself to them, and that the product to which we are devoting our enterprise and our research is being improved with the object of giving greater service to the user. The keener the competition we have to meet from other materials of foreign origin, the greater is our incentive to develop and improve our own home materials.

Work of the Association.

This brings me to my concluding remarks which are addressed to those within the industry. Throughout the year we have been unceasing in our efforts to further the use of road tar. Our advertisements have appeared regularly in the Technical Press; our travelling representatives have called on surveyors and users of tar throughout the country; our tar barrel labels, bearing the slogan "Tar Roads Grip," have been extensively used by members; our talking film "Coal Mine to Road" has been used by the District Tar Boards, who have arranged exhibitions for the mutual benefit of buyers and sellers of tar in their respective areas, and it is also being shown at a minimum of 120 educational centres during the year; the short version "Tar" is being exhibited at a minimum of 300 cinema halls throughout the country; a large number of articles and paragraphs have appeared in the Press, dealing with road tar; we have exhibited at the British Industries Fair, Birmingham, and shown our film there; and the Association has been represented at conferences and technical meetings, and articles and papers have been contributed.

Turning to the technical and experimental side of our work, surface-dressing experiments have been conducted under the auspices of the Ministry of Transport; experimental work on the surface-treatment of asphalt has been carried out; a demonstration section of tar concrete has been laid in the West Riding of Yorkshire, in co-operation with the County Surveyor; the demonstration lengths on the Kingston By-Pass continue to give satisfactory service; and the results so far obtained from the Alresford experiment are satisfactory. Much valuable work is alo being done in co-operation with the British Standards Institution.

We have just recently issued a pamphlet entitled "Some Activities of the B.R.T.A.," which shows the scope of the Association's work. While, however, the progressive activities of the Association make an excellent record, we must not lose sight of the bulwark effect exerted on the tar position generally by the Association. Without that work and co-operation, our active and well-organized competitors would have met with only limited opposition, and without the present substantial demand for road tar the question of the disposal of about 2 million tons of tar annually would have been a matter of the most serious concern to the Gas and Coke Oven Industries of this country.

On the grounds of utility and national economy, we must ensure that an ever-increasing quantity of home-produced tar is used on British roads, and if the Association is to be used to the fullest advantage, it must receive the support of all producers and distillers throughout the Industry.

Society of British Gas Industries

AUTUMN GENERAL MEETING AND LUNCHEON

The Autumn General Meeting and Luncheon of the Society of British Gas Industries took place at the Hotel Metropole, Northumberland Avenue, London, on Thursday last, Nov. 3—the Right Hon. L. S. Amery, M.P. (President of the Society), being in the chair at both functions.

LUNCHEON SPEECHES.

Mr. E. J. Fox (Chairman of the Council), proposing the toast of "The President," said he felt it a great privilege to extend to Mr. Amery a hearty welcome to their autumn meeting. The Society had been fortunate in having as its Presidents from year to year men distinguished in all spheres of public life. Their Presidents had been most helpful. Their presence among them had added to the Society's prestige, and their addresses had always been of an outstanding character. The President this year, Mr. Amery, was a well-known member of the House of Commons, who had held important positions in previous Governments, including that of Secretary of State for the Dominions, and he took the greatest interest in the development of the British Empire. ["Hear, hear."] During his year of office, Mr. Amery would no doubt be impressed with the importance of the Gas Industry, and with the desire of that Industry to serve the nation to the best of its ability. The Gas Industry was one of our key industries, supplying as it did a commodity of prime necessity, and of daily use in the vast majority of the homes of the people, and essential to a very large number of trades and industries.

The Most Pressing Problem.

Much had been heard lately with reference to wise spending. A correct balance between spending and saving was of supreme importance in the re-establishment of national prosperity. Money was to-day available at low rates of interest. They all knew that, by setting in motion the wheels of industry, unemployment would be reduced, taxation lessened, and the purchasing power of the consumer (upon which the prosperity of the Gas Industry depended) increased. And yet everybody waited, and nobody knew what was going to arrest that condition of stagnation. On the other hand, it was recognized by all that the one pressing problem before the country was the problem of finding occupation for our unemployed. ["Hear, hear."] He would give them two extreme cases of possible spending—the one apparently foolish, the other apparently unnecessary. In the one case, one spent a million pounds in finding work for the unemployed in building up a sand wall on the seashore, with the knowledge that the next tide would demolish the wall, and find occupation on the following day for re-building it. This occupation might be styled foolish, but it at least had the advantage that future years were not committed to maintenance charges. In the other case, one spent a million pounds in putting down and in opening up a new coal pit, and, when completed, found the product superfluous to the requirements of the world, and the lower cost of production (which would normally give one an advantage) discounted by the operations of a recently introduced Act of Parliament which, in its working, penalized the efficient and bolstered up the inefficient. And contrary to the first venture of building a sand wall, one found oneself possessed of an undertaking which involved heavy maintenance charges and which could only be expected to do justice to itself if given free scope of competition against the inefficient.

He could not help feeling that wise and safe expenditure at the present time might be considered to embrace the extension of gas and water undertakings, both of which played so large a part in raising the standard of living of our people, and that extensions in these two directions would prove neither foolish nor unnecessary, but, on the contrary, would provide no small measure of useful work through channels well organized and directed for relieving the unemployment problem. They hoped the President would use his influence with the Government and Parliament to enable the Industry to carry out wise spending as regarded gas undertakings, whether municipal or privately owned.

An Expanding Industry.

The Rt. Hon. L. S. Amery, M.P., in reply, said he was very much obliged to Mr. Fox for the kind terms in which he had proposed the toast. These words were all the more flattering in that they came from one who had achieved a high position in industry through the efficiency and success of the great works for which he was responsible. Mr. Fox had launched out into the interesting theme of what constituted unprofitable spending. He gave as an instance the spending of a million pounds in building up a wall of sand which was washed away by the next tide. He (Mr. Amery) was not sure that even this extreme instance was not better than spending the million pounds for men to kick their heels in idleness and discontent at home, and be a nuisance to their wives. ["Hear, hear."] The other instance was that of a super-efficient coal mine, where the reward of efficiency was barred by legislation. Well, the quality of sand was unchangeable, and the waves could always get the better of one, but legislation promoted by one party could, if it was sufficiently foolish, be undone by another party. Mr. Fox, however, had then brought them back to what interested them more directly, and that was

the possibilities of employment that lay in the development of the great industry with which those present were associated. The Society represented, of course, not so much the Gas Industry, as all those industries which were ancillary to it—but, he would add, not only ancillary, but indispensable, for what would the Gas Industry be without the holders which the members erected, without the pipes in which the gas was carried, without the refractories and without the stoves and other instruments through which the gas was used? Without all these things gas would be merely an unpleasant smell. [Laughter.] He could think of no purpose to which gas, by itself, without some appropriate instrument, could be devoted, except possibly to that of suicide. Therefore the members of the Society could claim equal partnership in this great Industry, which was one of the nation's major industries. It was an Industry with a capital of £180,000,000, consuming something like 18,000,000 tons of coal per annum—far too little, he would add—and which employed something like 100,000 workers, who never quarrelled with it. [" Hear, hear."]

The Gas Industry was not only a healthy industry, but it was one which was steadily expanding, in face of keen competition and a certain amount of unfair restriction. [" Hear, hear."] It was characteristic of this expansion that, even during the last few years of depression, the use of gas in industry had developed. This was due to the fact

THE PRESIDENT.

The Rt. Hon. L. S. Amery, M.P.

Mr. Amery was on the staff of " The Times " 1899-1909, and edited " 'The Times' History of the War in South Africa " ; he was also the author of " The Problem of the Army " (1903), and was called to the bar of Inner Temple in 1902. Other offices he has held include Parliamentary Under-Secretary of State for the Colonies, 1919-21 ; Parliamentary and Financial Secretary to the Admiralty, 1921-2 ; First Lord of the Admiralty, 1922-4 ; Secretary of State for the Colonies, 1924-9 ; also Secretary of State for Dominion Affairs, 1925-9 ; M.P., Birmingham (South) and Sparkbrook divisions from 1911. He served in France, Belgium, and the near East from 1914 to 1916 ; Assistant Secretary to War Cabinet ; on staff of Supreme War Council, Versailles, and on personal staff of Secretary of State for War 1917-18. He was temporary Lt.-Col. on General Staff.

that, even with present prices and under prevailing conditions, there were many industrial processes which were far more effectively undertaken and controlled with gas. Its thermal efficiency made it, in fact, better than other forms of fuel which at first sight might seem to have an advantage over it.

Possibilities in Every Direction.

One heard a great deal now about " Back to Coal." Yes, by all means—but not back to crude coal, which was one of the worst conceivable amalgams of a number of highly valuable constituents. The most efficient way of using coal was to break it up into these constituents, which individually and collectively were worth very much more than the coal itself. It was to this task, with its increasing concentration on research and its enterprise in developing new methods, that their Industry had devoted itself. It had a large field of extension. Look at the 40 million tons of coal which were every year burned in the grates of this country, instead of being utilized far more effectively in the form of gas. There were possibilities in every direction. There was no limit practically to the opportunities of the Gas Industry. There were, however, considerable limits, tiresome limits, imposed by the legislation of the past. The Gas Industry suffered from having been invented more than a century ago, and from having been for many years only an illuminant, and also practically the only illuminant. Consequently all the legislation of the past century had been concentrated on protecting the local household against unfair treatment by the local lighting authority. The law had very little perception of the fact that gas would have to hold its own in competition with electricity; it had still less perception of the fact that gas, while still remaining an illuminant, would have to maintain successfully its position also as one of the main sources of heat and power. The law also ignored the fact that the Gas Industry, while it supplied certain needs of a public character, was also a very important manufacturing industry, producing a wide variety of essential products which, though in a sense bye-products, were vital to the Industry itself. In all these respects the Gas Industry had been hampered by legislation of the past, and for its full development it demanded to-day a far more flexible treatment in the matter of rates. It demanded greater freedom in regard to amalgamation and financial co-operation, and in connection with the working up or marketing of its residuals. In all these respects gas undertakings were still severely handicapped as business concerns by the fact that in the eyes of Parliament they were still in the main parochial institutions. He thought there was hope that in this matter there might be effective change—more effective than the tinkering changes of the past decade. It was only part of the change which had to come over the outlook of Parliament in regard to industrial problems generally. For several generations Parliament had had little thought for helping industry, but had been mainly concerned with social affairs. He, however, knew of no more fruitful task to which Parliament could devote itself than the freeing of industry internally from unnecessary shackles which no longer corresponded to present-day conditions.

" I think," concluded the President, " that we are on the eve of an era of great progress and development. We need new ideas and boldness in their execution, and I think that, in expressing this view, I am expressing the conscious or sub-conscious view of the great mass of our people. I believe that the best days of this nation are still to come. We enjoy the great advantage of having Sir Francis Goodenough with us to-day, and we cannot let him go without asking him for a few words of encouragement."

An Industry Full of Faith and Hope.

Sir Francis Goodenough said he would have regretted not to have an opportunity of expressing their thanks to the President. While the Society stood for the very important and valuable ancillary industries which depended upon the Gas Industry for their existence, the Gas Industry depended upon these ancillary industries for its existence also; they were mutually inter-dependent. It had not been his pleasure to listen to a more masterly exposition of the position, difficulties, and future prospects of the Gas Industry than they had just heard from the President. [" Hear, hear."] They were much indebted to him for his excellent speech. It was particularly interesting, because it was based on facts and a sound view of the position from start to finish. He congratulated the Society very much upon having Mr. Amery as President for the coming year. They in the Gas Industry were full of faith and hope for the future, and charity towards their competitors. [Laughter.] Judging from the Electrical Press for the past week, he (Sir Francis) was supposed to be in a great state of funk regarding the future of the Gas Industry, because of the words of warning he had been uttering as to the competition the Gas Industry had to anticipate in the future, and the importance of being prepared in every corner of the Industry to meet this competition. But his friends of the Electrical Press did not quote him as having said that, if the Gas Industry put its house in order everywhere; if it made its service to the public what it should be in every quarter—then the Gas Industry would have nothing to fear from competition. This was his very definite view. He was confident that the Gas Industry was going to put itself right where it was weak. It was much stronger than their electrical friends would like to think; and the way to still greater strength was a full realization of its weaknesses and a determination to put them right. If he heard his competitor admonishing himself to get better ready for

competition, he would feel more anxious than he would do if he thought his competitor was sound asleep and unconscious of having anything to improve in his equipment or personnel. He could assure the electricians that the Gas Industry was not anticipating a decline, but more prosperour days than it had ever before seen—as he was sure that this country had before it greater prosperity than anyone living had ever yet witnessed. He felt confident that the bottom of the depression had been reached, and that already they had begun to rise again; he believed there was a light in the sky, and that there was prosperity coming—but only if they all of them continued to put their shoulders to the wheel. They would not get on by wishing, and they could not meet competition by wishing. He was glad to feel that the Gas Industry was in a sound position generally for meeting the future and for taking advantage of all the opportunities that were coming along. It would, however, be in a still better position if it were relieved of the shackles to which Mr. Amery had referred. They were delighted to hear that they could depend upon the President's wholehearted support in getting these shackles removed. He believed Parliament was conscious of the necessity of removing them, and that it would not be long before the Industry was free to proceed on sound commercial lines, to the benefit of both the community and the Industry.

Mr. ALEXANDER COMLEY said that the country was to-day in need of men of vision, men of courage, and men of undoubted ability. Their President had proved himself to be such a man, and he would like those present to tell him why Mr. Amery was not a member of the Government. He hoped the day was not far distant when those valuable attributes which were Mr. Amery's would again be at the disposal of the country.

BUSINESS MEETING.

The first business of the meeting was the presentation by Mr. E. J. Fox, as Chairman of the Council, of a report of the Society's work during the past six months.

Report of the Chairman of the Council.

The Society is much indebted to its Immediate Past-President, the Rt. Hon. Lord Eustace Percy, M.P., for the very able and valuable address he presented at the Annual Meeting in May, in which he dealt with "Economy in Social Services."

British Commercial Gas Association.—Congratulations are offered to the Association on their very successful 21st Annual Conference held at Leeds in September and best wishes for the future success of the Association and the Gas Industry it stands to serve. The Society was happy to co-operate with the Institution of Gas Engineers in the formation of the Association and has always given its hearty support.

Canadian Gas Association.—The Society was represented at the Twenty-Fifth Anniversary Convention of the Canadian Gas Association at Winnipeg in June by Mr. Arthur H. Lymn, who conveyed his greetings and good wishes.

British Industries Fair, Birmingham, 1933.—The Society in co-operation with the other bodies in the Gas Industry is again organizing a Gas Industries Section at the Fair next year. Arrangements are now well in hand and practically all the space available has been allotted. A joint Conference is again being arranged to be held during the Fair, when important addresses will be delivered by leaders in the Industry.

The Information Bureau provided by members of the Heavy Sections of the Society, in conjunction with the British Commercial Gas Association, which has proved such an outstanding feature at the Fair during the last two years, is to be continued next year.

British Standards Association.—The Society is represented on the Committee set up by the British Standards Association, and during this year has considered the standardization of Protective Lenses for Welders and others engaged in the use of oxy-acetylene flame and electric arc welding.

Association of Public Lighting Engineers.—A number of members of the lighting section exhibited at the Exhibition of Public Lamps and Lighting Equipment held at Blackpool during the Association's Conference in September.

Building Centre.—Several sections of the Society have co-operated with the Gas Industry in connection with the Building Centre at 158, New Bond Street, London, W. 1. The Centre has been established for the mutual benefit of architects, contractors, and manufacturers of materials and equipment and all those engaged in the building industry, and to stimulate public interest in building. It is hoped that this co-operative effort will be helpful in increasing the knowledge of architects, builders, and others in the many advantages of gas apparatus for domestic and other purposes. The Centre is now open, and members particularly interested will no doubt take an opportunity of visiting it from time to time.

Gasholders.—The suggested regulations embodying safety precautions to be observed by contractors when carrying out repairs to gasholders submitted to the Home Office have been considered by them, and they have returned a Revised List embodying their suggestions. The Committee is collaborating with the Institution of Gas Engineers in regard to the matter, and it is hoped to submit a Revised Draft which will be acceptable to the Home Office.

Building Exhibition.—The Gas Industry was well represented at the successful Building Exhibition held at Olympia, London, in September at which a number of our members exhibited.

Refractories.—Since the last report, a strong appeal has been made to the members of Sections 1, 6, and 10 for additional financial support for the British Refractories Research Association. It was clearly evident that unless further support was forthcoming the Association would be compelled to cease the valuable work it was doing on behalf of manufacturers and users of refractory materials.

The need for the appeal was accentuated when the Department of Scientific and Industrial Research of the Government intimated their inability to continue the grant facilities on the existing scale in consequence of the national financial crisis. In fact, the Department had stated that they would not be prepared to give the Association any further assistance at all, unless it materially increased its income from industrial sources.

It is satisfactory to be able to report that the appeal was quite successful, promises exceeding a total of £5000 per annum were received from manufacturers and users. In these improved circumstances, the Department agreed to afford the Association further grant facilities though necessarily on a reduced scale.

The Association, therefore, will not only be enabled to continue its valuable work on the same scale as hitherto, but it will be able to embark upon an extended programme of research work. In achieving these good results, the Society and other Associations in the Gas Industry have played a most valuable part.

City and Guilds of London Institute.—The prizes in the City and Guilds of London Institute in the recent examinations in Gas-Works Practice, Gas Supply Practice, and Gas Fitting have been duly awarded and announced in the Technical Press.

General Meetings.—As the outcome of a suggestion made by Alderman F. J. West at the Annual Dinner of the Society in May an arrangement has now been come to with the National Gas Council and the Institution of Gas Engineers by which in future the two General Meetings of the Society will, whenever possible, be held:

> The day following in the same week as the Annual Meeting of the National Gas Council and in the Autumn after the Autumn Research Meeting of the Institution of Gas Engineers.

It is hoped that this will result in economy of time and money to those attending the various meetings.

Gas Salesmen's Circles: S.B.G.I. Gold Medal.—It is a matter of regret to the Council that none of the younger generation connected with the gas undertakings of the country have shown sufficient initiative to compete for the Gold Medal awarded by the Society by presenting technical papers. There are no competitors this year, and the Society Medal has not been awarded.

Mr. FOX then formally moved the adoption of the report.

Mr. FRANK WEST seconded. He said in connection with the subscriptions which were going to be sent to the British Refractory Research Association as a result of the appeal, it was gratifying to the Council that Refractories Section 10 were nearly all subscribing. There were only thirteen members of the section, and they were subscribing an amount of just over £27, and in the other sections in which there were five members, the subscriptions amounted to £13; in the near future there would probably be some further subscriptions.

Mr. R. J. MILBOURNE said that he very much regretted to find that for the second year in succession they had been unable to award the Society's Gold Medal. It would seem that something was wrong with the rule governing the award of this Medal. He had read several papers presented by salesmen at Circle Meetings, which had seemed to be worthy of recognition. It was difficult to imagine what would be termed a "technical paper" from a salesman. He was not necessarily interested or concerned with the technicalities of the apparatus he was bringing before the public; and he was quite sure that several of the papers which had been submitted were well worthy of recognition and encouragement. He suggested that the Council should

take into consideration whether the rules governing this award could not be altered.

The PRESIDENT said that this seemed to be a useful point for consideration; after which the resolution for the adoption of the report was put to the meeting and carried unanimously.

SOME REFLECTIONS ON PRESENT DAY TRADING.

An Address by the Chairman, Mr. E. J. Fox.

I am sensitive of the fact that I am addressing a body of manufacturing and trading colleagues engaged with myself in serving the great gas producing industry—an industry which for enterprise and efficiency in production and distribution probably comes first among our great national industries.

If I address myself to some technical subject dealing with one of my commercial products, I shall run the risk

THE CHAIRMAN,

Mr. E. J. Fox, Managing-Director of the Stanton Ironworks Company, Ltd.; Chairman of Davy Brothers, Ltd.; Director of Crompton-Parkinson, Ltd.; and Past-President of the National Federation of Iron and Steel Manufacturers.

The first twenty years of Mr. Fox's career were spent in the electrical business, divided equally between Messrs. Crompton & Co., Ltd., and Messrs. Willans & Robinson, Ltd. During the last twenty years Mr. Fox has occupied himself in the Iron and Steel Trade, having first been associated with Messrs. Stewarts & Lloyds, Ltd., and, during the past fourteen years, with the Stanton Ironworks Company, Ltd., which Company he joined as Managing-Director in 1917. The operations of the Stanton Company have been materially developed since Mr. Fox joined them. The first step was to absorb the Holwell Iron Company, operating furnaces and foundries at Melton Mowbray. Subsequent to that, the blast furnace and foundry sections of the business of Messrs. James Oakes & Co., of Alfreton, were taken over by the Stanton Company. More recently still, financial interest was purchased in the limestone property of Messrs. Bowne & Shaw, Ltd., of Wirksworth, and during the past four years the Stanton Company have purchased the whole of the share capital of Messrs. James Pain, Ltd., whose ironstone properties are located in the Kettering district. Further, during the past few years the Stanton Company have sunk and developed a new coal pit at Bilsthorpe in Nottinghamshire, the output of which added to their three existing collieries will give them an output of coal of some 2½ million tons per annum. During the period of Mr. Fox's association with the Stanton Company the business has developed into that of the largest manufacturers of cast-iron pipes in Europe, the third largest producers of pig iron in Great Britain, and one of the largest ironstone property owners in the country. Mr. Fox's active work in connection with welfare among the employees, and particularly the successful putting into operation of Works Committees embracing the Stanton Company's 14,000 workpeople, the success of which has been demonstrated over ten years' practical work, are well known. Mr. Fox was educated at Rugby School.

of being accused of taking advantage of the Chair, and if I address myself to some extraneous subject, I shall probably run the risk of speaking without first-hand knowledge. I have therefore decided to touch on one or two of the daily problems with which we are concerned in our manufacturing and trading operations—and which to-day assume interest and importance probably greater than under more normal conditions of world trade.

It is significant, in the first place, that the constituent members of this Society are mostly units of moderate size—of a size where the personal touch in direction and in management remains predominant. And coincident with this fact is the important consideration that as a body our individual members have largely continued to do justice to the capital employed by them.

It is a common belief that production on a large scale is necessarily more economical than that on a small scale, and that small units of production are necessarily inefficient, out-of-date, and certainly out of fashion in many quarters.

But it is my belief that the unit of moderate size will survive and that many of the larger units (for examples of which we have mostly to look outside our own industry) which have taken shape under the definition of rationalization, will fail to achieve the results promised and hoped for. The problem of successfully operating a large unit may prove in practice more difficult than would have proved the problem of rehabilitating the constituent members of the unit whose condition of distress was the primary cause for amalgamation.

On the other hand, of course, time has proved the success of the policy of undertakings growing larger by gradual expansion and absorption of smaller units, particularly where considerations of trade have dictated the expansion. But units which have grown suddenly large through amalgamation, aiming primarily at elimination of competition, would seem to have a more difficult task in front of them.

I cannot leave this subject without drawing attention to an outstanding example in our midst where amalgamation has resulted in a large undertaking proving successful by centralizing only those operations which go towards elimination of waste and increase of efficiency, and decentralizing those operations where personal service to the customer, and management of the individual unit, have been preserved as in the workings of a smaller undertaking.

SELLING GOODS ABROAD.

Doubtless the size of a trading unit is of importance in the export business; and, in this connection, we are frequently rebuked as a nation for our lack of enterprise in selling our goods abroad. As far as I can judge, a thought seems prevalent that we should resort to the mass production of "salesmen," whose outstanding qualification should be an intimate knowledge of the language of the country in which the trade is to be carried on, and whose qualifications should perhaps be directed more to the social than to the practical or business side.

For dealing with products of a technical nature, such as are mostly embraced within the scope of this Society, I think I should place primary importance on the individual representing headquarters abroad knowing his subject; in other words, knowing the business in which he is dealing; and after that I should stress the importance of knowing the language. Presumably representation in a foreign country takes the form of one of three procedures—either (*a*) representation by a local individual or concern handling other agencies, or (*b*) representation by a local individual or concern handling other agencies, with your own official permanently attached to the concern, or (*c*) representation through your own office with your own staff.

It follows, of course, in the case of all three procedures that a knowledge of the language and of the customs of the country in which trade is sought is essential.

But almost of equal importance is the necessity of agencies worked under any of these three alternative procedures being regularly visited from headquarters; and it is on the subject of these "connecting" visits that criticism is mostly levelled at us both in regard to the personnel deputed for paying the visits and in regard to absence of knowledge of the foreign language.

Generally speaking, I believe we are inclined to be too economical in the outlays which we are willing to incur in our representation abroad, particularly in comparison with corresponding selling expenses incurred at home. Too often do we expect the foreign agent to carry the full burden of the costs and to recoup himself at intervals when he draws commission on an occasional sale.

I believe better results might be obtained if the foreign agent were adequately subsidized, and regular steps taken by visits from headquarters to assure the agency being energetically worked.

We shall probably be in agreement in saying that the most satisfactory form of agency in the majority of foreign countries is that referred to under procedure (*c*)—namely,

your own office with a whole-time staff devoting their time to the subject of the agency; and, second best, the alternative under (*b*), where your own man is attached to the foreign agency. For most countries and for most undertakings these proposals are too expensive; and where this proves to be the case I am wondering whether there is not scope for increasing foreign business by joint representation among those making competitive products, as opposed to joint representation among those making non-competitive products, which latter procedure has too often proved difficult and unsatisfactory in practice.

Co-operation among rivals at home, making the same product, for working one particular foreign market need not mean financial amalgamation at home, nor even co-operative selling in other markets. And it seems to me that representation in a foreign country by a representative familiar with the technicalities of the particular product is preferable to representation by one dividing his time between diverse products.

Training for Outside Representation.

These thoughts bring us to the question of the training of suitable candidates for outside representation. We are all of us being asked to take into our businesses young men who have left a public school at the age of eighteen or nineteen, and others, rather older, who have finished a 'Varsity training at the age of twenty-one or twenty-two.

It is an old saying that it is a mistake to crack a nut with a steam-hammer, and equally do I think it is wrong that a young man who has had the benefit and the cost of a public school education, and perhaps added to that a further 'Varsity training, should drop down to competing with those less fortunate from an educational point of view, and who enter the productive side of industry at an age of fourteen or sixteen.

My view is that the ex-public school or 'Varsity man should aim at the commercial side by spending one or at most two years in passing through the shops, with a view *not* to mastering the problems of production, but to accustoming himself to general manufacturing methods and to the nature of the products. And that he should then enter the commercial side and thoroughly learn office routine, with a view either to outside representation later on, or to acting as a key man inside the office. In short, it seems to me that generally speaking the key men on production must begin their technical training at an early age, and that by starting earlier these men become more valuable as Works men on production than they usually become on the commercial side.

It is certain that the ex-public school or 'Varsity man by spending a year or two in passing through the shops will have an opportunity of acquiring an insight into a subject which later years seldom provide—namely, a knowledge of the working man, and he will during that period have an opportunity of learning the intrinsic value of the character of the British craftsman. But outside exceptional cases, I should not advocate these men starting so late in life looking to the production side for a livelihood.

On rather a different subject, where an undertaking is publicly owned, as opposed to privately controlled, I cannot help feeling that there is value in creating an atmosphere and knowledge that promotion goes by merit, and that relationship carries with it no preference. To create this atmosphere and to remove suspicion, I believe that, as far as practicable, it is undesirable for principals to surround themselves with relatives. It is usually bad for the young relative, and it prejudices the management in maintaining an atmosphere of impartiality.

Equally do I think that the management should be conversant with cases where their under-managers and foremen employ relatives in their own and in neighbouring departments. And the fact that cases of relationship are known to the management as a matter of routine, will automatically go far towards checking favouritism and of disarming suspicion on the part of the workers.

Equally should the under-managers in the form of the foremen be encouraged to send in from time to time a list of young fellows under their control who are worthy of encouragement and of promotion. Too often the fate of a young fellow for promotion depends upon opportunities in his own department; whereas the scope of the undertaking as a whole should be available to any employee showing signs of desire to advance. Further, the ability of an outstanding young workman is sometimes only realized when he has obtained a better position elsewhere, and some other undertaking benefits by the training which the young man has gained at your expense.

Pioneer Work.

Due to our conservative habits as a nation, we are liable to fail in giving adequate support to enterprise which aims at reducing costs and increasing efficiency, and to this extent pioneer work in England is more discouraging than it is in other countries. And as an illustration I might cite my own experience in the development and establishment of the centrifugally made iron pipe.

The invention was perfected and developed in England, other countries of the world taking up the process after England had spent a large amount of capital in proving the commercial possibilities of the process. But in England the pioneer found it difficult in the early stages to market the product among the larger and more powerful consumers. The new commodity had to look for support mainly among the smaller and medium sized users, and it was on their support that this epoch-making process in the production of iron pipes for the conveyance of gas and water has been developed and is gradually supplanting the product of the older processes.

The centrifugally-made iron pipe has saved the gas and water industry hundreds of thousands of pounds in reducing the capital cost of mains extensions or replacements, and this has been achieved through the support given to the development of the process in the first instance by the smaller undertakings, without whom the process would never have found a start.

Connected with this phase of the subject is the strange mentality of prejudice against adopting the speciality of one particular producer. The manufacturer in question may have spent years in perfecting his particular speciality, but it suffers under the prejudice of being the speciality of one particular producer. As soon as imitators come along the speciality is more generally accepted, and often the less proved-out product is accepted as representative of the original speciality, and may succeed in prejudicing the work and efforts of the pioneers.

Standardization.

Then again, as a nation we are lacking in taking full advantage of standardization, and are liable to nullify the advantages of standardization with our own individualism.

Let me again give you one example from my own experience. You would have thought that the cast-iron pipe for the conveyance of gas and water would have been an ideal product for standardization. Standardization has taken place, but the advantages have subsequently been largely thrown away by the stipulation on the part of the consumer either to have his special marks cast on each product, or to see each pipe tested during manufacture, or some infinitesimal departure in dimensions which just fails in enabling the commodity being treated as a stock article and being safely put into stock for subsequent sale. The result is that the British producer cannot safely work for stock, and his normal working operations are being continually interrupted and his costs increased.

Finally, however much industry and life may be mechanized, nothing can detract from the importance of the physical and mental well-being of the human element. The human working force is the most delicate, sensitive, and important part of the industrial machine.

Much can be done, I think, in drawing closer together management and men by enlisting co-operation and sympathy in the everyday problems met with in any producing industry. Suggestion schemes, if properly administered, present a useful and fruitful source for bringing the individual worker into the interests of the undertaking. Safety-First Committees, if organized as part of the business, are a fruitful means for enlisting the interest of the men in reducing the costs of compensation payments, liable to become expensive in some industries. And they certainly exert a humanizing influence on the employees.

And, finally, Works Committees, eight of which I have had working for the past fourteen years, covering different establishments in different districts, have convinced me of the value of having machinery established for dealing month by month with the many small problems arising daily, the solution of which is outside the scope of the Departmental Managers or Foremen, and which can only be disposed of with the knowledge on the part of every employee that suggestions or points raised by him through the medium of the Works Committee will receive attention.

In conclusion, I would apologize for the variety of subjects which I have touched upon in this short address, but they are each one of them subjects which arise in the conduct of our everyday business. If I have been instrumental in creating further thought on any of the matters mentioned, I shall have been well repaid for the risk incurred in inflicting upon you my views on these everyday subjects, which many of you have already had occasion to solve in your own way to meet your own conditions.

Vote of Thanks.

The President endorsed very warmly what Mr. Fox had said in his address in regard to representation abroad, the two essentials being knowledge of the technical side of the business and knowledge of the local language. He had so often

had it brought up against him in foreign countries that the representative could tell would-be customers nothing more than was stated in the catalogue with which he was supplied. He was quite incapable of saying on his own behalf whether certain modifications suggested by the customer could or could not be carried out. Knowledge of the language, and more than that, knowledge of the history and ways of the people, was invaluable. The first key to the hearts of a great many people, especially among the smaller nations, was a knowledge of their language—not necessarily to the extent of speaking it fluently but just to show interest in it. This was worth more than any number of introductions.

Mr. C. A. Goodall, in proposing a very hearty vote of thanks to Mr. Fox for his address, remarked that it covered a very wide sphere and touched upon many subjects. One that struck him particularly was this. Having just completed three weeks' very strenuous competition in connection with municipal politics he had been struck by a question which had come before them at all the meetings he attended. They had, unfortunately, had to fight on the present occasion against very strong opposition, against a very noisy element, which had been based on the question which at the present time was more particularly before the working classes—namely, the means test. As he had listened to Mr. Fox's address—more particularly in the earlier part—the thing that struck him, as it must have struck them, very forcibly not on one occasion but on many during the past three weeks, was whether they were altogether wise in the wide amalgamations that were taking place in this country, doing away with the individuality which had been the backbone of the country for many years. In the old days, where one had these small firms, the head of the firm, whether it was a limited company or a partnership undertaking, could go into the works day by day and be in the position of knowing all the workers by name and could add that little bit of human feeling which gave so much encouragement. The consequence was the worker who had been serving in the same firm for years brought his sons into the business with the feeling that he was part and parcel of that particular firm, and that the success of that firm was dependent on him as part of that firm. Although these amalgamations might be advantageous from one point of view, the question was whether the gain on that side was equal to the loss on the other side. It was a matter they all had to face—whether standardization, amalgamation, and all these various things, in spite of their huge success from the production point of view, were worth what they were going to cost in the other direction.

Mr. R. J. Milbourne, in seconding the vote of thanks, said that it had been a very instructive address. The Industry had to a large extent during the past few years been unfortunately concerned more with production than with selling manufactured goods. He suggested that the present depression was due rather to over-production than to anything else; but he quite agreed with Mr. Goodall that rationalization had its drawbacks. The majority of concerns would prove more successful when linked up to smaller undertakings. But there were examples of the smaller unit supplying at a lower price than the larger, which was ample proof of the limitations of rationalization. Another point was Mr. Fox's original and daring suggestion of a single representative for a number of competing firms. Such a proposition had not been put before a trading society before. He thought he had good authority in saying that "no man could serve two masters;" but there was, nevertheless, a great deal in Mr. Fox's suggestion. There might be cases in the colonies where a representative had to travel hundreds of miles to interview a prospective buyer, and it would be an advantage if he could put forward the claims of several competing firms. One could not help feeling sympathy with the Chairman in regard to what he had said about the introduction of spun-iron pipes into this country, and probably into the world. It was generally the lot of pioneers and inventors that someone else reaped the fruits of their work. Another point was the small amount of encouragement that users of these pipes gave to standardization. There was surely no single article on the market so suitable for standardization as the ordinary pipe; and yet there were all these little difficulties which made it impossible to stock standard pipes so that they could be supplied at a moment's notice, owing to an infinitesimal departure in detail which could be of no importance whatever. After all, the pipe was buried in the ground, so that it seemed immaterial whether it was a

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particular weight or whether it had one's name stamped on it.

The CHAIRMAN proposed a hearty vote of thanks to the President for his speech at the luncheon and for presiding over their meeting that afternoon.

The PRESIDENT said that so far as he was concerned it had been a great pleasure to be there. He had gained a great deal by listening to Mr. Fox's address, and in so far as a President could be useful as well as ornamental, if, in Parliament, he could help in any way, he would be only too glad to do so.

The Meeting then terminated, and the members adjourned for tea.

Bendigo Gas Company.

Although during the period it had effected a reduction of 12½% in the price of gas, the Bendigo Gas Company (Australia) at its half-yearly meeting declared a dividend of 7%. It was suggested at the meeting that the Company might shortly be in a position still further to reduce the price to consumers.

In submitting the annual report, the Chairman of Directors (Mr. J. B. Young) said: "Considering the world-wide depression it is satisfactory to be able to present a half-yearly report of such a successful and encouraging nature, and to be able to recommend a dividend of 7%. The revenue from gas shows a shrinkage which to some extent is due to the fact that the Directors decided in March last to reduce the price of gas by about 12½%. By doing so, we naturally expected increased output. To popularize the use of gas for cooking we have been holding once a week demonstrations which have been largely attended, and have become very popular. Each week we are distributing interesting recipes which are greatly appreciated, and the demand for these is increasing rapidly, which we consider will encourage housewives to use their stoves in producing dishes described in these recipes. We have been able to show a reasonable profit and to put aside another £500 to our debenture redemption account, which now stands at £1500. Besides this we have paid the full amount of interest which we contracted to do to our debenture-holders."

Mr. Young pointed out that during the half-year 90 appliances had been fixed, and, although the Company had passed through a severe time with fractured mains, the unaccounted-for gas was the lowest on record. During the 10 years of Mr. W. A. Simco's management nearly 40 miles of mains and services had been laid, showrooms had been altered, cookery demonstrations introduced, 1200 new meters installed, and 2000 tested and repaired. In addition, the large gasholder had been constructed, and a complete carbonizing unit provided. During Mr. Simco's régime the quantity of unaccounted-for gas had been reduced by 36%, and more than 3000 appliances had been fixed.

Mr. Simco said that every member of the staff had carried out their respective work to the best of their ability, and had worked willingly and conscientiously. During the past 10 years £40,000 had been spent by the Company in installing new services and new plant, and it had mostly been done out of profits.

Parliamentary Intelligence.

[From Our Special Correspondents.]

House of Lords.

Special Orders.

The Special Orders Committee met on Thursday, Nov. 3, and approved the Special Orders in respect of Bideford and Spalding which are now awaiting the affirmative resolution of the House.

The Earl of Halsbury has put down a motion for Tuesday, Nov. 15, that the Bath Gas Order, which was reported from the Select Committee on June 29 last, be approved with the modifications proposed by the Select Committee. It will be remembered that this Order gave rise to an acute controversy as to the principle of two basic prices in one area.

House of Commons.

Special Order.

A Special Order on the application of the County Borough of Rotherham has been presented and ordered to lie upon the Table of the House.

LIGHT, ECONOMICAL and RUST FREE,

BRIGHT IN SERVICE

GAS INDUSTRY APPLICATIONS

Canopies, globe galleries and diffusers, connections, oven linings, refrigerator linings, flue pipes, meter parts, fire surrounds, warehouse lamp bodies and reflectors, water heater tops, piping, splash plates and poker handles.

Also paint for gasholders (for protection) and for lamp-posts (for protection and visibility).

APPLICATIONS of aluminium to the gas industry are commended on all sides for two good reasons

(1) The metal is rustless
(2) The metal resists the products of gas combustion.

It ensures to the sections of an installation for which it is used a long life and a lasting smartness. Add to this the metal's light weight (and therefore economy in manufacture) and its durability.

For utensils, too, aluminium can be well commended. It has the endorsement of British, American and Continental authorities, for its hygienic cooking. Long usage has also proved the metal to be economical in gas and in cooking time and labour-saving.

ALUMINIUM

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ALUMINIUM PRODUCERS, ADELAIDE HOUSE, KING WILLIAM STREET, LONDON. E.C. 4.

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G.J. 9.11.32.

GAS MARKETS & MANUFACTURES

Stock Market Report.

[For Stock and Share List, see later page.]

Business on the Stock Exchange last week was to some extent dominated by the Government's final conversion operation. This took the form of an issue of £300,000,000 in 3% stock at 97½, which was very largely over-subscribed in a few hours. The gilt-edged section was mainly affected, prices showing considerable fluctuations, and it may be some little time before the market settles down to the new conditions. A certain curtailment in the volume of business was apparent in many other sections, but the undertone remained firm and prices were well maintained.

The demand for Gas stocks and shares continued unabated, and there was a large volume of business again last week, many issues being marked up to new higher levels despite the fact that a certain amount of profit-taking was in evidence. Ordinary stocks, particularly Gas Light units, received a large measure of the support. This is not surprising when taking into consideration the class of security and the yields obtainable at current prices on the 1931 dividends, as illustrated in the following table:

—	Current Middle Market Price.	Dividend, 1931.	Yield %.
		%	£ s. d.
Commercial	104½	5⅝	5 12 5
Croydon sliding-scale	139½	7	5 0 4
Gas Light units	25s.	5⅛	4 9 8
Liverpool	115	6	5 4 4
Newcastle units	21s. 6d.	5⅜	5 0 0
South Metropolitan	122½	6	4 18 0
South Suburban	115½	6¼	5 8 2
Tottenham	132½	6⅞	5 1 10
Wandsworth	137½	7	5 1 9

The Directors of the Imperial Continental Gas Association have declared an interim dividend of 5% on £5,600,000 of capital stock, as against 7½% for the corresponding period on £2,800,000, the capital having doubled since last year by the distribution of a capital bonus of 100%. The present dividend of 5% is comparable with 3¾% for the corresponding period on the increased capital, and the Directors state that the higher distribution is being made with a view to diminishing the difference in rate between the interim and final dividends.

A Gas issue this week is that of the Romford Gas Company, which is offering for sale by tender £60,000 of 4% redeemable preference stock at a minimum price of £102½ per £100. The flat yield at the minimum price is £3 18s.%, or £3 16s. 9d.% allowing for redemption at par in 1958. The last day for receipt of tenders is Monday, Nov. 21, at 11 a.m.

Current Sales of Gas Products.

The London Market for Tar Products.

LONDON *Nov.* 7.

There are no changes to report in the prices of tar products, which are as follows:

Pitch is firm at 100s. per ton f.o.b.

Creosote is 3½d. to 5d. per gallon f.o.b., according to specification.

Refined tar is 4d. to 4¼d. per gallon in bulk at makers' works.

Pure toluole is about 2s. 7d.; pure benzole, about 1s. 11d.; 95/160 solvent naphtha, about 1s. 7½d.; and 90/140 pyridine bases, 3s. 9d. to 4s.—all per gallon naked at makers' works.

Tar Products in the Provinces.

Nov. 7.

The average prices of gas-works products during the week were: Gas-works tar, 33s. to 38s. Pitch—East Coast, 85s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 85s. f.o.b.* Toluole, naked, North, 1s. 7½d. to 1s. 9d. Coal-tar crude naphtha, in bulk, North, 5½d. to 5¾d. Solvent naphtha, naked, North, 1s. 4d. to 1s. 4½d. Heavy naphtha, North, 10½d. to 11d. Creosote, *ex* works, in bulk, North, liquid and salty, 2¼d. to 2¾d.; low gravity, 1¼d.; Scotland, 2¼d. to 2¾d. Heavy oils, in bulk, North, 4¾d. to 5¼d. Carbolic acid, 60's, 1s. 6½d. to 1s. 7d. Naphthalene, £9 to £10. Salts, 55s. to 75s., bags included. Anthracene, "A" quality, 2½d. per minimum 40 p.ct., purely nominal; "B" quality, unsaleable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *Nov.* 5.

Little or no change can be recorded in this district during the week. Pitch continues firm, but other products are somewhat lifeless.

Crude gas-works tar.—Actual value is 45s. to 50s. per ton *ex* works.

Pitch.—Supplies are scarce, with export value nominal at 85s. to 90s. per ton f.o.b. Glasgow. Wagon loads command 90s. to 95s. per ton f.o.r.

Refined tar.—Very few orders are being placed, and value is easy at 3¾d. to 4d. per gallon f.o.r. naked.

Creosote oil.—Stocks are increasing and values are irregular. B.E.S.A. Specification is 3½d. to 3¾d. per gallon; low gravity, 3d. to 3¼d. per gallon; and neutral oil, 3¼d. to 3¾d. per gallon—all *ex* works in bulk.

Cresylic acid.—Prices continue easy with stocks increasing. Pale, 97/99%, is 11½d. to 1s. per gallon; dark, 97/99%, 10d. to 11d. per gallon; and pale, 99/100%, 1s. 2d. to 1s. 3d. per gallon—all f.o.r. in buyers' packages.

Crude naphtha.—Value continues steady at 4½d. to 5d. per gallon, according to quantity and quality.

Solvent naphtha.—90/160 grade is 1s. 2d. to 1s. 3d. per gallon, and 90/190 grade 11d. to 1s. per gallon.

Motor benzole is easy in this district at 1s. 4d. to 1s. 5d. per gallon f.o.r. in bulk.

Pyridines.—90/160 grade is 3s. to 3s. 3d. per gallon, and 90/140 grade 3s. 3d. to 3s. 6d. per gallon.

Benzole Prices.

These are considered to be the market prices for benzole at the present time.

	s. d.		s. d.	
Crude benzole	0 10½	to	0 11	per gallon at works
Motor "	1 6½	"	1 7	" " "
Pure "	1 10	"	1 11	" " "

Trade Notes.

Wailes Dove Research Bulletin.

From Messrs. Wailes Dove Bitumastic, Ltd., of Collingwood Buildings, Newcastle-upon-Tyne, we have received a copy of their Research Department Bulletin No. 6—being a summary of a report of the American Gas Association's tests on pipeline coatings. The Company will be pleased to send a copy of this publication, post free, to any of our readers who may be interested in this type of work.

Sulzer Bros. (London), Ltd.

To meet the demand for British machinery, Messrs. Sulzer Bros. (London), Ltd., of 31, Bedford Square, W.C. 1, have entered into an agreement with Messrs. Sir W. G. Armstrong Whitworth & Co. (Engineers), Ltd., to manufacture certain Sulzer specialities exclusively at their Scotswood Works, Newcastle-upon-Tyne. The reputation of this firm is well known, and their works are well equipped. They are already thoroughly acquainted with Sulzer designs and production methods, having manufactured Sulzer Diesel marine engines under licence for over 12 years, and they also hold a licence to build Sulzer traction Diesel engines. Centrifugal pumps, Diesel engines, refrigerating plant, &c., will be manufactured from drawings supplied by Messrs. Sulzer Bros., Ltd., of Winterthur.

Corporation Undertakings' Results.

Newton-in-Makerfield.

The total expenditure on revenue account during the year amounts to £21,590, against £23,143 for 1930-31, while the income has been £25,626, against £27,605, leaving a gross profit of £4035. After deducting interest and sinking fund charges, the balance is £280. The amount of coal carbonized during the year was 5495 tons, and the total quantity of gas made was 116,748,000 c.ft., being an average make per ton of 84·13 therms. The number of consumers increased by 219 to 4929.

STOCK AND SHARE LIST.

Official Quotations on the London and Provincial Stock Exchanges.

[For Stock Market Report, see earlier pages.]

Issue	Share.	When ex-Dividend.	Dividends. Prev. Hf. Yr.	Dividends. Last Hf. Yr.	NAME.	Quotations. Nov 5. (Provincial Exchange Nov. 4.	Rise or Fall on Week.	Transactions. Lowest and Highest Prices During the Week.
£			% p.a.	% p.a.				
1,551,868	Stk.	Oct. 3	7½	7½	Alliance & Dublin Ord. ...	102—112	...	107⅞—109⅝
374,000	,,	July 4	4	4	Do. 4 p.c. Deb.	80—90	...	89½
557,655	,,	Aug. 22	7	7	Barnet Ord. 7 p.c.	132—142	...	...
300,000	1	Oct. 17	1/9⅝	1/4⅛	Bombay, Ltd.	21/—23/-*	...	22/6
177,750	Stk.	Aug. 22	9	9½	Bournemouth sliding scale	192—202	+2	201
550,050	,,	,,	7	7	Do. 7 p.c. max. ...	145—155	...	150½
439,160	,,	,,	6	6	Do. 6 p.c. Pref. ...	135—140	...	137½—137½
50,000	,,	June 20	3	3	Do. 3 p.c. Deb. ...	75—80	...	77½
162,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	100—105	...	102
210,000	,,	,,	5	5	Do. 5 p.c. Deb. ...	125—130	...	125
357,900	,,	Aug. 22	7½	7½	Brighton, &c. 6 p.c. Con. ...	138—143	...	...
540,000	,,	,,	6½	6½	Do. 5 p.c. Con. ...	127—132	...	130—132
195,500	,,	,,	6	6	Do. 6 p.c. B Pref.	135—145	...	...
1,287,500	,,	Aug. 8	5	5	Bristol 5 p.c. max.	108—109*a*	...	...
120,420	,,	June 20	4	4	Do. 1st 4 p.c. Deb. ...	96—99*a*	+2½	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	95—98*a*	+2½	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	115—120*a*	...	...
955,000	,,	Oct. 3	8	7	British Ord.	136—141	+6½	136½—137
100,000	,,	June 20	7	7	Do. 7 p.c. Pref.	140—150	...	...
350,000	,,	—	—	—	Do. 5½ p.c. Pref. ...	107—112	...	...
120,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	90—95	...	...
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	105—115	...	...
160,000	,,	July 4	5	5	Cambridge 5 p.c. Deb. ...	117—122	...	...
100,000	10	May 23	6	6	Cape Town, Ltd.	7½—8½	...	...
100,000	10	Apl. 29	4½	4½	Do. 4½ p.c. Pref. ...	6—7	...	...
150,000	Stk.	June 20	4½	4½	Do. 4½ p.c. Deb. ...	90—95	...	93
626,860	,,	Aug. 8	6	6	Cardiff Con. Ord.	102—107	...	...
237,860	,,	July 4	2½	5	Do. 5 p.c. Red. Deb.	105—110	...	...
157,150	,,	Aug. 8	6½	5	Chester 5 p.c. Ord.	91—96*b*	...	...
98,936	1	Oct. 17	2/-	2/-	Colombo, Ltd. Ord.... ...	25/—30/-*	...	28/6
609,204	1	Oct. 17	/10'90	/11'47	Colonial Gas Assn. Ltd. Ord.	15/—17/6*	+3/9	15/10½—16/1½
296,053	1	,,	1/2'54	1/3'80	Do. 8 p.c. Pref.	17/6—20/-*	+6/3	19/3—19/6
1,848,830	Stk.	Aug. 8	5½	5	Commercial Ord.	102—107	...	106½
475,000	,,	June 20	3	3	Do. 3 p.c. Deb. ...	74—79	...	...
220,272	,,	—	—	—	Do. 5 p.c. Deb. ...	120—125	+2	121—122½
807,560	,,	Aug. 8	7	7	Croydon sliding scale ...	137—142	...	...
469,590	,,	,,	5	5	Do. max. div.	95—100	...	...
500,000	,,	July 4	5	5	Do. 5 p.c. Deb.	120—125	...	...
542,270	,,	Aug. 8	10	7	Derby Con.	150—160*c*	...	...
55,000	,,	July 4	4	4	Do. 4 p.c. Deb.	75—85*c*	...	...
209,000	,,	Sept. 5	5	5	East Hull Ord. 5 p.c. ...	95—100	...	...
179,500	,,	Aug. 22	5½	6	East Surrey Ord. 5 p.c. ...	108—118	...	...
155,019	,,	June 20	5	5	Do. 5 p.c. Deb. ...	118—123	+1	120—122
1,002,180	,,	Sept. 19	†6½	†5	European, Ltd.	122—127	...	125—126
19,405,992	,,	Aug. 8	5⅝	5⅝	Gas Light & Coke 4 p.c. Ord.	24/-—26/-*f*	...	24/6—25/3
2,600,000	,,	,,	3⅛	3⅛	Do. 3⅛ p.c. max.	80—85	+2	82½—85⅝
4,477,106	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	101—104	+1	101—103½
6,102,497	,,	June 20	3	3	Do. 3 p.c. Con. Deb. ...	80—83	...	81½—82
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	110—115	...	...
3,500,000	,,	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	110—114	...	111—112½
264,011	,,	Aug. 22	—	6	Harrogate New Cons. ...	110—115	+6	110
82,500	,,	Aug. 22	7	7	Hastings & St. L. 5 p.c. Conv.	130—140	...	...
258,740	,,	,,	5½	5½	Do. 3½ p.c. Conv.	100—105	...	102½
70,000	10	Oct. 17	‡10	‡10	Hongkong & China, Ltd. ...	9½—10¼*	...	...
213,200	Stk.	Aug. 22	6	6	Hornsey Con. 3½ p.c. ...	117—122	+5	121—122
5,600,000	,,	June 6	15	14	Imperial Continental Cap.	202—212	+7	201—209
223,130	,,	Aug. 8	3½	3½	Do. 3½ p.c. Red. Deb.	90—95	...	...
235,242	,,	Aug. 8	8½	8½	Lea Bridge 5 p.c. Ord. ...	150—160	+8	150—151
2,145,907	,,	Aug. 22	6	6	Liverpool 5 p.c. Ord. ...	114—116*b*	+½	...
245,500	,,	June 20	5	5	Do. 5 p.c. Red. Pref. ...	100—110*b*	...	...
306,083	,,	July 15	4	4	Do. 4 p.c. Deb. ...	98—103*b*	+4	...
165,786	,,	Sept. 5	10	8	Maidstone 5 p.c. Cap. ...	155—165	...	...
56,176	,,	June 20	3	3	Do. 3 p.c. Deb. ...	69—74	...	...
75,000	£	June 20	‡10	‡10	Malta & Mediterranean ...	7½—8½	...	...
892,000	—	Oct. 1	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	97—102	...	100½—101
171,978	Stk.	Sept. 5	5	5	M. S. Utility "C." Cons. ...	100—110	+7½	...
718,657	,,	,,	4	4	Do. 4 p.c. Cons. Pref.	90—95	...	90
112,126	,,	July 4	4	4	Do. 4 p.c. Deb. ...	95—100	...	...
148,955	,,	,,	5	5	Do. 5 p.c. Deb. ...	115—120	...	...
675,000	,,	21 May '31	‡6	‡6	Montevideo, Ltd.	35—45	...	41—41½
2,061,315	,,	Aug. 8	5½	5	Newcastle & Gateshead Con.	21/6—22/6*d*/	+-/6	...
682,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	90½—91½*d*	...	...
691,705	,,	June 20	3½	3½	Do. 3½ p.c. Deb. ...	89—91*d*	...	...
977,285	,,	Apl. 29	5	5	Do. 5 p.c. Deb. '48...	105—107*d*	...	...
274,000	,,	Aug. 8	5	5	Newport (Mon.) 5 p.c. max.	92—94*a*	+1	...
199,940	,,	Aug. 22	7½	7½	North Middlesex 6 p.c. Con.	135—145	...	...
396,160	,,	Aug. 8	5	5	Northampton 5 p.c. max. ...	96—101	...	...
300,000	,,	Apl. 18	9	7	Oriental, Ltd.	90—95	+2½	...
205,162	,,	June 20	8	8	Plym'th & Stonehouse 5 p.c.	142—152	...	...
504,416	,,	Aug. 22	8	8	Portsm'th Con. Stk. 4 p.c. Std.	142—152	...	...
241,446	,,	,,	5	5	Do. 5 p.c. max. ...	97—102	...	...
114,000	,,	Aug. 8	5	5	Preston 5 p.c. Pref.	105—110	...	...
686,312	,,	July 18	4	4	Primitiva 4 p.c. Rd. Db. 1911	77—82	...	...
889,813	,,	June 20	4	4	Do. 4 p.c. Cons. Deb.	77—82	...	...
150,000	10	Sept. 19	6	6	San Paulo 5 p.c. Pref. ...	6½—7½*	...	...
1,795,958	Stk.	Sept. 5	6	6	Sheffield Cons.	110—114*e*	...	...
95,000	,,	July 18	4	4	Do. 4 p.c. Deb. ...	92—96*e*	...	...
133,201	,,	Sept. 5	5	8½	Shrewsbury 5 p.c. Ord. ...	113—118	...	...
90,000	10	June 6	15	15	South African	4—6	...	...
6,709,895	Stk.	Aug. 8	7	5	South Met. Ord.	120—125	+2	120—124
1,135,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf.	140—145	+1	142
1,895,445	,,	July 4	3	3	Do. 3 p.c. Deb. ...	80—83	...	81—83
1,000,000	,,	July 18	4	5	Do. 5 p.c. Red. Deb.	109—114	...	...
91,500	,,	Aug. 8	8½	8½	South Shields Con.	134—136*d*	...	...
1,548,795	,,	Aug. 8	6	6	South Suburban Ord. 5 p.c.	113—118	...	118
800,000	,,	,,	5	5	Do. 5 p.c. Pref.	113—118	+3	115
668,337	,,	June 20	5	5	Do. 5 p.c. Deb.	121—126	+1	123½—125½
647,740	,,	Aug. 22	5	5	Southampt'n Ord. 5 p.c. max.	100—105	+7	...
121,275	,,	June 20	4	4	Do. 4 p.c. Deb.	95—100	...	...
350,000	,,	Aug. 8	—	9/-	Swansea 5½ p.c. Red. Pref.	110—114	+1½	113½
200,000	,,	June 20	6½	6½	Do. 6½ p.c. Red. Deb.	105—110	...	...
1,076,490	,,	Aug. 8	6½	6½	Tottenham and District Ord.	130—135	...	133—134
300,000	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	120—125	...	125
199,005	,,	June 20	4	4	Do. 4 p.c. Deb. ...	95—100	...	98—100
85,701	,,	Sept. 19	6	6	Tuscan, Ltd., 6 p.c. Red. Db.	67—72	...	...
346,069	,,	Aug. 22	7	7	Uxbridge, &c., 5 p.ct. ...	130—140	...	135
88,330	,,	,,	5	5	Do. 5 p.c. Pref. ...	110—115	...	...
1,322,220	,,	July 4	7	7	Wandsworth Consolidated	135—140	+2½	137—140
971,373	,,	,,	5	5	Do. 5 p.c. Pref.	115—120	+3	117½—119½
1,167,964	,,	June 20	5	5	Do. 5 p.c. Deb.	122—127	+2	123½
158,400	,,	Aug. 22	6*g*	5	Winchester W. & G. 5p.c. Con.	98—103	...	...

Quotations at :—*a*.—Bristol. *b*.—Liverpool. *c*.—Nottingham. *d*.—Newcastle. *e*.—Sheffield. *f*.—The quotation is per £1 of stock. *g* Paid £3, including 10s. on account of back dividends. * Ex. div. † Paid free of income-tax. ‡ For year.

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Manufacturers of GAS RETORTS, GLASSHOUSE FURNACE & BLAST FURNACE BRICKS, LUMPS, TILES, and every Description of FIRE BRICKS.

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(This announcement is inserted gratuitously.)

PETER—WITH ONE EXCEPTION

With one exception Peter is an ordinary little fellow. Chubby, likeable, just five-and-a-half, full of life and fun and on occasions—be it admitted—of naughtiness.

Just now Peter's rather important, for this is his first term at school, and he's grappling with the intricacies of "A B C" and "Twice Two": difficult subjects to all men of five-and-a-half, but even more difficult in Peter's case because—bad luck—he's totally blind. That's his One Exception.

Peter learns reading, writing, and 'rithmetic through the medium of "Braille"—dull stuff compared with the coloured picture books of most five-and-a-halfs. However, he's a stout lad is Peter, and he's making great progress.

Would you like to know more about him? How, in spite of his "One Exception," he is being educated, and, when older, technically trained and usefully employed.

There is a long waiting list of "Peters" throughout the British Isles, for whom training and accommodation must be provided in the immediate future.

Will you help with a donation or annual subscription? Any sum, large or small, will be gratefully received.

Here's a suggestion. Your eyesight is worth 3d. a year to you. Send Peter and his handicapped pals 3d. for every year you've had it. Now, please, in case it slips your memory. Good idea!

THE CHAIRMAN,

SCHOOL FOR THE BLIND

(Founded 1838).

Swiss Cottage, LONDON, N.W.3

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